UiA University of Agder

Educational Games for eHealth

Using Games as a Tool to Teach Disease Precautions

IDA-MARIE SOLLI

SUPERVISORS
Martin Wulf Gerdes
Karl-Heinz Frank Reichert
Santiago Gil Martinez

University of Agder, 2021
Faculty of Engineering and Science
Department of ICT

Master

Abstract

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This master thesis investigated how an educational game could affect the ability to remember infectious disease precautions, guidelines, and hygiene rules over time in students and young adults in Norway. It also compared the ability to remember and implement these precautions taught in an educational game to the digital course "*Training in Protective Measures*" at the University of Agder. A high-fidelity digital prototype of an educational game was created for the purpose of this thesis project, with learning materials based on the teachings in the course.

Qualitative research methods have been used for the evaluation of the proposed educational game. A control group took in the course "*Training in Protective Measures*", while a test group partook in the evaluations of the prototype game twice. The data collected during the evaluations was used to check for indications to any differences in learning outcomes, as well as potential changes in the learning outcomes over time.

For an educational game to be useful, it should also meet expectations of players towards games. To evaluate if the developed prototype could provide a learning environment that meets these expectations, it was also investigated how the gaming experience was among the test group.

Overall, the evaluations provided valuable results that indicate that the proposed educational game can be a useful tool when educating about infectious disease prevention, while providing a positive gaming experience to the players.

Preface

This project was chosen as I have always had a passion for games and integrating games and game theory to something with a different purpose than just entertainment, sounded even better. When the physical campus opened again the fall of 2020, all students and faculty had to pass the course "Tr*aining in Protective Measures*", and I remember discussing it with some fellow students as we felt it was unengaging and repetitive. So, when time came to narrow down on a topic for this thesis project, looking closer into games based on that course became the choice to investigate if it was possible to create something more engaging based on the same content.

I want to thank all the participants that volunteered their time to take the course and play the prototype of the game. I especially want to thank my supervisors, Martin Wulf Gerdes, Karl-Heinz Frank Reichert and Santiago Gil Martinez for their guidance throughout the project period. Their incredible amount of support, help, and patience made this possible.

Abbreviations

CEGE – Core Elements of the Gaming Experience

CEGEQ – Core Elements of the Gaming Experience Questionnaire

NPC – Non-Player Character

SD – Standard Deviation

UiA – University of Agder

ZPD - Zone of Proximal Development

Table of Contents

1 Introduction

Playing games might for many be viewed as something you do in your spare time, rather than with an educational purpose. The area for games in an educational setting is growing and becoming more common as game designers create new and wonderful worlds to explore, developers transfer a curriculum into computer code, teachers and tutors are creative in how they share their knowledge, in an ever-changing world that is becoming more and more digital.

When the world was hit with a pandemic in 2020, the need for digital tools used in learning of behavioural rules such as distance keeping and disinfection became much larger seemingly over night as schools, universities, and many workplaces had to adapt to new form of normal. In this thesis we will explore the use of an educational game to prevent the spreading of COVID-19 and compare its use to an online course.

1.1 Background on Field

When the COVID-19 pandemic hit the world early in 2020, the lives of millions of people changed fast. We lived in a digital world, but the pandemic created a larger need than before for technology to adapt to the changing ways of life. Digital collaboration and video conferencing tools, such as Zoom (Zoom, 2021) and Microsoft Teams (Microsoft, 2021) among others, became something most people were familiar with. Such collaboration tools were commonly used when the traditional classrooms had to close for physical education, in order to facilitate virtual online university lectures, to have staff meetings, or even just to keep in contact with distant friends and family. But this new boom in the use of digital tools also came with challenges. Not all had previous experience with using these tools, and this created a steep learning curve for people. With such challenges in adapting to a new normal during the pandemic, alternatives for traditional learning, such as online courses and serious video games among others, could be useful tools when utilized well. For teachers, lecturers, professors, and others providing knowledge in an educational setting, saving time and resources by utilizing additional tools in their teachings can potentially be beneficial for all parties involved.

With the pandemic, there is also a constant need to keep people informed and up to date on current recommendations regarding disease precautions and guidelines. At the University of Agder (hereafter abbreviated as "UiA"), students and faculty must complete a compulsory course before they are allowed to enter the campus (UiA, 2020a), called "*Training in Protective Measures*" (UiA, 2020b). This is one way at UiA to learn about hygiene rules. Other places where people might look for information are government webpages such as the ministry for health (Helsedirektoratet, 2020), news broadcasts, social media, learning through talking to friends, family, co-workers, and other in-person communications. However, not all resources of information are trustworthy, and the risk of misinformation can be high in channels with less moderation or credibility (European Commission, 2020).

"Serious games" are games not created purely for entertainment purposes but that have been created with another serious purpose in mind. Serious games can be explored in many contexts

of use, such as healthcare, simulation training for different tasks and professions, to mention some, but for this thesis we will use serious games in the context of educational purposes.

1.2 Focus Areas

Many areas related to health, wellbeing, and disease prevention could be interesting to explore further in the context of educational games. When faced with limited contact, some people might struggle with their mental wellbeing due to loneliness (Mental Health Foundation, 2020; Røde Kors, 2020) or finding it hard to exercise when their gym is closed due to COVID-19 restrictions, some might struggle with eating healthy in such a time. Some people struggle to remember the different hygiene rules as they change when more information is discovered about the disease, or the recommendations and guidelines themselves become more complex, and thus harder to adjust to. Sometimes local areas can have more strict or additional rules regarding personal hygiene than on the national level, and even those persons who are usually good at following such rules can risk forgetting some when faced with choices on the spot. The University of Agder has an obligatory online course that all students and staff must complete in order to visit the UiA campuses physically (UiA, 2020b). This course might be perceived as boring with little engagement for some of the people taking it, while others might find this way of learning informative and useful. In this project, the hygiene rules presented in the game will be the same as those in the first three modules of the (UiA, 2020b) course "*Training in Protective Measures*". The online course consists of seven modules in total, but with limitations regarding time and resources, it is not possible to review all modules in a short-term project, and focus was placed on three of the modules that can also be relevant in other parts of everyday life.

This project will have the primary area of focus at:

- ❏ Learning and practicing hygiene rules and precautions important to reducing the spread of infectious diseases.

The target user group for this project are students and young adults in Norway.

1.3 Problem Statement

COVID-19, or Corona as it often is called in casual discussions, have become well known across the globe in 2020. The disease led to government restrictions in Norway mid-March 2020 (Helsedirektoratet, 2020), and many people started working from home at that time, studied from home, and had less chances to travel both locally and abroad, due to the pandemic. Even though people could still leave their homes, or spend time together physically, it was recommended to limit contact with other people to lower the chances of transmission of the virus.

With the government restrictions in Norway changing and being updated regularly based on the latest situation, the advice to the public has also changed along the way. Some hygiene rules, such as washing of hands often, are easy to remember and follow through with. While

other restrictions, such as physical distance when in public, can be harder as it might be easy to forget in the moment when one sees an old friend, or greet someone with a handshake as we are used to do from before the pandemic. Some advice changes along the way, while in Norway the recommended minimal distance is currently set to 1 meter, while some other countries recommend 2 meters, to give an example.

There is a lot of information about what to do, and what not to do, when it comes to hygiene rules and precautions during the pandemic. Some people are good at following them, while others are not. Could a game help people remember the basic hygiene rules better? The "big" rules such as washing hands, keeping a minimal distance, sneezing into the pit of the elbow, are for many easy to remember as they are repeated often, but other hygiene rules, or even location-based rules, can be harder for some to remember. Such as how many can stand in the elevator at once, when to put on a facemask, among others.

Can an educational game help people remember hygiene rules, guidelines, and recommendations better? Can practicing this in a game change how people practice these guidelines in their everyday life?

1.3.1 Research Questions

Research Question 1: How different is a student's ability to remember, and implement, COVID-19 precautions at UiA in their daily life, depending on whether they took a course or played a serious game with the same learning content?

Research Question 2: How does an educational game affect the ability to remember teachings of COVID-19 hygiene rules and precautions over time in young adults in Norway?

1.4 Approach

1.4.1 Project Phases

There are several phases to this project, and the obvious first phase is the ***planning phase***. To narrow down on the scope of the area to explore, this goes hand in hand with processing the ideas and decide what to focus on, and what to not investigate further. In this phase also generalized ideas regarding the game, particularly regarding the gameplay and game design, are brought to light. During the planning phase, when a focus area has been decided upon, planning what theories are needed for further research, methods for conducting the user experience evaluations, how to analyse the results from the assessment, and how to understand and apply the results in a useful and beneficial manner.

When planning the project is completed, the ***prototyping phase*** begins. In early prototyping, a low-fidelity paper-based prototype can be useful to evaluate how some general functionalities for the game can be applied, such as playing environment, navigation, placements, interface,

among some of the functionalities (Nielsen, 2003). The low-fidelity prototype will be useful for the project process before, during, and after, creating a storyboard for the prototype ideas. Low-fidelity prototypes have the advantage that end-users feel more confident to provide honest feedback as the prototype itself signals the early stages of a development (Nielsen, 2003). When ideas have been tried and developed during the low-fidelity prototyping, work on a high-fidelity prototype created in Unity can begin. The high-fidelity prototype will be a semi-functional game, but with limitations to time and ability for the project, some issues are expected to be present towards the end of the prototyping phase.

With a prototype of the game created, ***user evaluations*** will be the next step. To evaluate a potential learning outcome from the game, compared to the UiA course "*Training in Protective Measures*" (UiA, 2020b), ideally participants in both the control group and the test group have not taken the UiA course previously. However, this can create some difficulties regarding the recruitment process. Therefore, it will not be required that participants be currently active students, but that they are at an age where they either soon will be a student, recently graduated student, or not a student at all but close to the same age as the typical student.

In the evaluation phase, the control group will take the course, while the test group will play through the prototype of the game. Both the control group and the test group will take similar questionnaires before and after their tasks, to evaluate a potential learning out come from each group, and to compare the groups to each other. The test group will in addition to questions regarding learning the topic, also fill out questions from the Core Elements of the Gaming Experience (hereafter abbreviated as "CEGE")(Calvillo-Gámez, Cairns, & Cox, 2015) questionnaire the first time they play through the prototype. The CEGE will be used to review whether the prototype has the potential to give an enjoyable gaming experience. The test group will play through the prototype more than once, as a potential change in learning outcomes can give interesting data for the project.

After the user evaluations are completed, the ***results*** will be analysed to locate potential learning outcomes from the control group and the test group. Here results from the pre-questionnaire and post-questionnaire will be compared to look for indications of change regarding knowledge about hygiene precautions, the results from the groups will then be compared to each other. The CEGE questions filled out by the test group will be analysed, whether the CEGE is present in the developed prototype or not, the results from the CEGE can provide useful information for future work in the context of teaching disease precautions and guidelines with educational games.

1.4.2 The Game

A prototype for a "serious game" will be designed and created for the purpose of this project. It will be a single player game developed in Unity using WebGL (Unity Technologies, 2015). It is intended to be browser-based, and not dependent on a certain device or mobile operating system, in order to increase the size of a potential target group. WebGL gives more freedom when developing, rather than locking the game to only certain devices, but games created with WebGL are not optimized for running on mobile phones and can create an additional challenge

during development, as well as accessibility when it comes to users having a stable internet connection. For testing purposes, the game will be made accessible to participants online on itch.io, as this is a free site commonly used for hosting games. The prototype of the game will only be programmed for the intended use on personal computers with a keyboard and a computer mouse as control devices, and as such, it will not be playable on regular smart phones.

The prototype will explore the potential of some common scenarios regarding hygiene rules and disease precautions. The player will have to adapt to these scenarios to complete the game safely, or not if they so choose. By placing the scenarios inside a game, rather than real life, the player can try and fail practice of hygiene rules without any real consequences to their or others' personal health and wellbeing. Saenz and Cano (2009) did an empirical study about experimental learning through simulation games and mentioned how the possibilities to make mistakes could be an important part of the learning process. They further mentioned how the possibility of interacting with decisions could have a positive effect on the learning outcomes.

The use of games and gamification in education is a growing area, and many might think of young pupils in this context, rather than adults. For many, taking a course online can be a motivating way to learn something new or improve an existing skillset, but others might have a greater need to be engaged with the contents, and exploring the possibility of an educational game can be interesting approach in such a situation.

1.5 Expected Contributions

The expectations of how a digital game might impact a person's learning outcome in this scenario are limited. Limitations regarding time and ability for the project itself reduce the number of scenarios and situations that can be explored during a short period of time, as well as how deep this can be explored at the time being. For a small-scale project such as this, there will also be limitations to the sample size, and validity a small sample size will provide for the results. However, one can expect to find indications to support a claim that an educational game can be a useful tool in the context of teaching infection precautions. If a game can create an enjoyable learning environment for the player, one might expect heightened chance of learning than with a game not found enjoyable by the player. On the other hand, some people might struggle with traditional learning and find a new medium for that purpose equally effective for them, when compared to the same content in a different setting.

2 Literature Research & State of the Art

2.1 Existing Games

There are many games on the market these days, but many games are created for purely entertainment purposes, rather than with an educational use in mind. When it comes to pandemic related games, the list becomes shorter, and depending on the target audience the options will be narrowed down further. *Pandemic* (2008) is a board game where the players cooperate to win against the game, and to win they must cure four different diseases. *Plague Inc.* (2012) is similar to *Pandemic*, but rather than curing diseases, the player must destroy the world to win. Both games are best suited for teenagers and adults, though the recommended minimum age of the games are set to 8 years old (*Pandemic*) and 9 years old (*Plague Inc*).

Both *Pandemic (*2008*)* and *Plague Inc. (*2012*)* are strategy games, and in addition to providing entertainment to their players, they also contribute with knowledge on how to respond to events, how diseases can infect and spread. It is worth mentioning that *Plague Inc* have recently developed an expansion, *Plague Inc: the Cure ,* that was released late in January 2021(Ndemic Creations, 2021). In this expansion of the game, created in collaboration with the World Health Organization (WHO), the player works against the disease to cure it and save the world (World Health Organization, 2021).

Can you save the world? (2020) is a family friendly game created early during the COVID-19 pandemic. The game is based on social distancing, and the awareness of distances to other people when out walking. In addition to practicing social distancing in the game, the player can also collect face masks to donate, and groceries to gain different advantages. The score in the game is based on how many lives that are saved due to social distancing.

In *Stop the Spread!* (2008) the player must make people sneeze into paper tissues, and later in the game they are also setting vaccines on the people in the game to stop the disease from spreading further. The game visualizes the effect of vaccines, and how quickly a disease can spread when not being treated correctly.

The above examples show that games exist that combine game playing with learning important behavioural facts about infection avoidance and spreading a disease. The concept of this thesis is more to learn the most important lessons rapidly rather than providing full-fletched strategy games experiences. Additionally, we want to create a game setting that relates to a specific university environment, as this project is related to the University of Agder.

2.2 Game Design and Principles

Salen and Zimmerman (2004) list six requirements for rules:

1. Rules limit player action.
2. Rules are explicit and unambiguous.
3. Rules are shared by all players.
4. Rules are fixed.
5. Rules are binding.
6. Rules are repeatable.

Rules are used to describe the formal system of a game, and while they constitute the rules of the game, the history or culture of the game is not taught with the rules. "*Rules constitute the inner, formal structure of games. All games have rules, and rules are one of the defining qualities of games*" (Salen & Zimmerman, 2004).

Hunicke, LeBlanc, and Zubek (2004) mention eight types of fun in their paper: *Sensation*, *Fantasy*, *Narrative*, *Challenge*, *Fellowship*, *Discovery*, *Expression*, and *Submission*. They also mention that fun is not limited to the types listed above. The types of fun are the aesthetic goals of a game, and it is common to pursue several types. *"Theory of games or formula that details the combination and proportion of elements that will result in "fun", this taxonomy helps us describe games, shedding light on how and why different games appeal to different players, or to the same players at different times "*(Hunicke et al., 2004)

To achieve meaningful gamification Nicholson (2015) have listed six elements inspired by game design; *Play*, *Exposition*, *Choice*, *Information*, *Engagement*, and *Reflection*. Although Nicholson (2015) mention how these can form the mnemonic RECIPE to create meaningful gamification in learning not created as games, they can be useful and important when constructing a serious game with an educational purpose.

Suppan, Gartner, et al. (2020) created a gamified e-learning module, "*Teaching Adequate Prehospital Use of Personal Protective Equipment During the COVID-19 Pandemic*". They created this as the COVID-19 outbreak led to a new need for education correct use of protective gear among health care workers. *"Electronic learning (e-learning) may provide significant advantages because it requires neither the physical presence of learners nor the repetitive use of equipment for demonstration"* (Suppan, Gartner, et al., 2020).

Game design follows certain patterns and establishes clear rules as a principle that we must include in the game design.

2.3 Learning Theories

McLeod (2018) discuss scaffolding and the Zone of Proximal Development (hereafter abbreviated as ZPD), though in the context in the article it is based on children, applying this to the context of an educational game could be an interesting approach. This is based on a more knowledgeable other, that is not always a teacher, and for the context of this thesis project the game would serve as the more knowledgeable other. *"Scaffolding consists of the activities provided by the educator, or more competent peer, to support the student as he or she is led through the zone of proximal development"* (McLeod, 2018). As illustrated in Figure 2.1 the use of guidance and encouragement can promote learning.

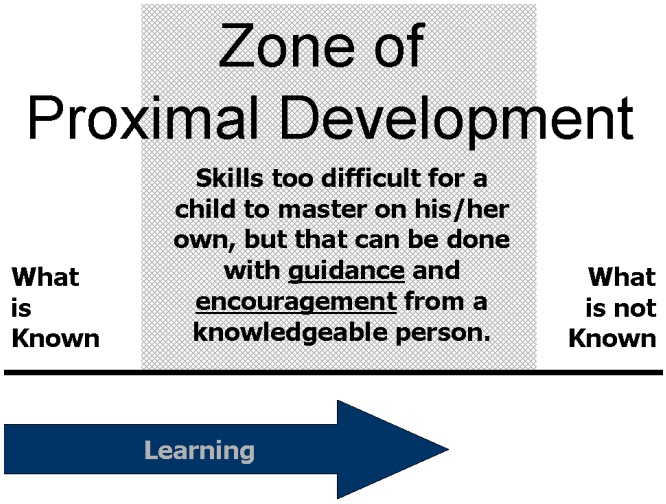

Figure 2.1: The Zone of Proximal Development as illustrated by McLeod (2018), although it is based on teaching children, applying it in other contexts can potentially give interesting results.

McLeod (2019) mention that knowledge is not absorbed as with traditional education but rather constructed by making connections with the provided information. Learning is an active process, and it is of importance that information is in a meaningful matter to become knowledge. Lack of structure can be a limitation regarding constructivism. McLeod (2019) go on to talk about how the teacher is the facilitator of learning. Adapting this in the context of a serious game as facilitator for learning can be an interesting approach.

"*Scaffolding consists of the activities provided by the educator, or more competent peer, to support the student as he or she is led through the zone of proximal development. Support is tapered off (i.e. withdrawn) as it becomes unnecessary, much as a scaffold is removed from a building during construction. The student will then be able to complete the task again on his own*" (McLeod, 2018).

McLeod (2018, 2019) go on to say that scaffolding is a key part of the constructivist classroom. The context behind this theory is based on children and classrooms but using a game character or the game itself as the teacher, these theories can bring a useful approach to scenarios presented in a serious game.

2.4 Learning about behaviour in Covid-19 pandemic

There are already created serious games and gamification items related to the COVID-19 pandemic with an educational purpose, one project of interest is "*A Serious Game Designed to Promote Safe Behaviors Among Health Care Workers During the COVID-19 Pandemic: Development of "Escape COVID-19"*"(Suppan, Catho, et al., 2020). Suppan, Catho, et al. (2020) included the 6 elements of Nicholson's meaningful gamification (Nicholson, 2015); Reflection, Engagement, Choice, Information, Play, and Exposition. The way Suppan, Catho, et al. (2020) applied this theory to their game, provided great insight for this project. "*The "choice" element relates to the autonomy the player has within the game. Giving the player the ability to make meaningful choices reinforces the player's autonomy and the feeling of being responsible for their actions. We therefore decided to let players make choices that IPC specialists would disapprove, and to experience (at least virtually) the consequences such potentially harmful choices might have*" (Suppan, Catho, et al., 2020). Using choices and consequences to bring knowledge to the user, can provide an interesting angle to the teaching methods.

3 Methodology

3.1 Game Design

Before development of the digital high-fidelity prototype can begin, planning the design process by using storyboards and low-fidelity paper prototypes, can be beneficial to gain a clear grasp of ideas, concepts and scenarios intended. A paper prototype can also gain more honest feedback from users, as it is at an early stage in the process (Nielsen, 2003). This phase can also use users closer to the project to evaluate the designs and ideas, such as friends or family, as they can provide honest feedback due to the simplicity of the prototype.

3.2 Prototype Development

The high-fidelity digital prototype of the game was developed in Unity, version 2019.4.10f1. Unity was chosen as the tool for game development in this project as it is a popular game engine with all the needed documentation and required functions, as well as also having support for creating in 2D, 3D, as well as other game and visualisation technologies.

Image 3.1: Here we can see how one of the assets used in the game was created. First it was drawn by hand, then scanned and transformed into vector graphics in Adobe Illustrator, where it was coloured, and the different parts was joined to form the device. On the image to the far right, we can see the result that is used in the game.

The obvious pencil lines and sketch look were done intentionally as the planned visual style. This style is fast to work with once a hand sketch is created with the intended result, and when planning what assets are needed parts can be reused. An example of this is the walls used to build the scene, is also used as a frame for the hint-posters.

3.3 Evaluation

The prototype was developed for the purpose of this thesis project to be used when evaluating.

As there are two main research questions to evaluate with this project, the following methods will be applied to the evaluation process of *learning outcomes regarding hygiene rules*.

To review the participants' learning outcomes regarding hygiene rules, a few simple pre-test questions will be asked, the same questions will be asked again after the game is completed, in order to compare changes in participants' correctness of the answers. These questions will be

based on hygiene rules and practices applied in the game, as well as based on the test questions from the UiA course.

Reviewing the test groups' answers after playing through the prototype can be useful to find out how well they remember the hygiene rules presented in the game, and if their results have changed since the first time playing. This will be measured through interviews with the participants based on reviewing the same hygiene rules and precautions as the previous time, as well as playing the game again.

3.3.1 Core Elements of the Gaming Experience Questionnaire

To assess the users' experience of playing the game, *Elements of the Gaming Experience* will be applied (Calvillo-Gámez et al., 2015). The CEGE questionnaire will be used with a Likert scale to measure the gaming experience. If the Core Elements of the Gaming Experience are present the gaming experience will not be negative, but it is not guaranteed that the experience is a positive one. The CEGE is usually applied with a 7-point Likert scale, however, for this project a 5-point Likert scale will be used instead. Using the CEGE can be useful to interpret whether the prototype has potential, but it will not give answers to whether the game is a good game. The CEGE questionnaire (Calvillo-Gámez et al., 2015) will be used after participants in the test group have conducted their first time playing through the prototype.

In the figure below, the relationships between the latent and observable variables are shown. The latent variables are shown in the circles, while the observable ones are shown in the squares. The questionnaire consists of eight scales, *Game-Play, Environment, Enjoyment, Control, Facilitators, Ownership, Puppetry,* and *Video-Game* (Calvillo-Gámez et al., 2015).

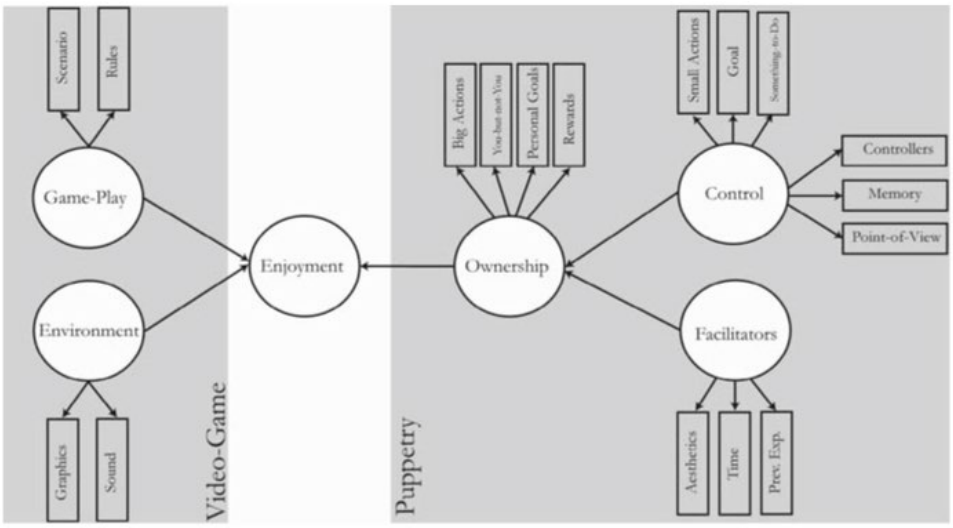

Figure 3.1: The CEGE-model (Calvillo-Gámez et al., 2015).

As the prototype of the game is created without sound or music, the items in the CEGEQ related to this have been removed from the questionnaire presented to the participants in the test group. This means, as the CEGEQ consists of 38 items, the questionnaire presented to the test group consists of 34 items from the CEGEQ.

The items removed were the following:

- The sound effects of the game were appropriate.
- I did not like the music of the game.
- The graphics and sound effects of the game were related.
- The sound of the game affected the way I was playing.

"The video-game is intrinsic to the experience, without it there would not be a gaming experience. The forming theory does not try to describe what makes a good video-game, rather it focuses on how it is perceived in terms of the forming experience." (Calvillo-Gámez et al., 2015)

Table 3.1 shows which statements are counted at what scales. This project will look closer at scale 1, with *Enjoyment* and *Frustration* in focus. As the prototype will not be a completed game, particularly enjoyment and frustration can provide useful information regarding how the users experience it.

Table 3.1: This table show how the different statements from the CEGEQ belong to the scales set (Calvillo-Gámez et al., 2015). The item numbers represent the different statements from the CEGEQ, where in the CEGE they begin at "1", in the survey-questionnaire presented to the test group in this project, they begin at "8".

Items	Scale 1	Scale 2
1, 4, 5	Enjoyment	–
2, 3	Frustration	–
6–38	CEGE	–
6–12, 38	Puppetry	Control
13–18	Puppetry	Facilitators
19–24	Puppetry	Ownership
25	Puppetry	Control/ownership
26–31	Video-game	Environment
32–37	Video-game	Game-play

Figure 3.2 shows how the CEGE model depicts the relationships of the latent variables, and as seen *Puppetry* and *Video-Game* leads to *Enjoyment*. The statements for scale 2 (Table 3.1) can provide a more detailed view of the impressions the users get, but as seen in Figure 3.2 all the latent variables relate to enjoyment.

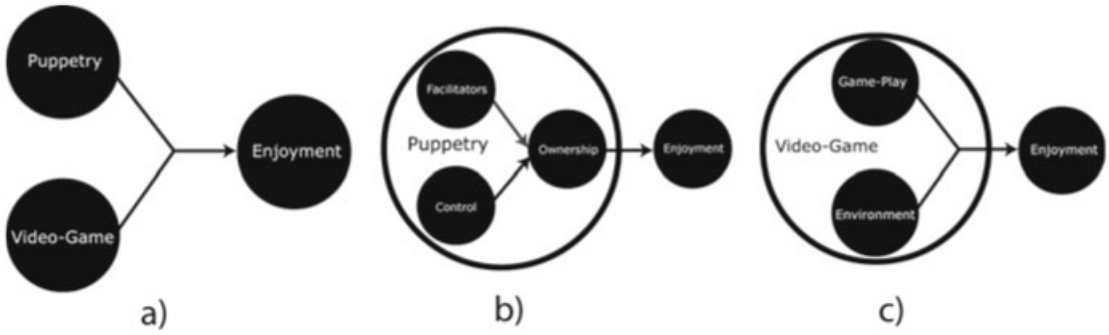

Figure 3.2: The CEGE model depicts the relationships among the latent variable. a) Puppetry and Video-Game create Enjoyment. b) Facilitators and Control create Ownership, inside Puppetry, which creates Enjoyment. c) Game-Play and Environment, inside Video-Game, create Enjoyment. (Calvillo-Gámez et al., 2015)

3.3.2 Remote Test Sessions and Observations

Participants in the test group will play through the developed prototype, and this will be observed. Body language and comments as they play, have the potential to provide useful feedback regarding future development of the prototype, to locate errors within the prototype, to find common occurrences where participants might struggle to make progression, or to provide insight to their problem-solving skills and thought process when facing a challenge. However, conducting the sessions during a time where in-person contacts are restricted due to COVID-19 can be a challenge. Therefore, having the ability to swiftly change to remote usability testing is necessary for this project.

The remote usability tests will be less time consuming than those sessions conducted in-person, as well as making the recruitment process more inclusive as the participants will not have a location requirement, as well as more convenient for the participants (Moran & Pernice, 2020). The usability tests conducted remotely have used the digital communication tool Discord (Discord, 2021) during the sessions, as this tool is free from costs, and offer the necessary requirements for ability to share screens, video chats, voice chats, and text chats.

When participants conducted their user evaluation of the prototype, the tests were done in two sessions for each participant. In the first session, three of the participants in the test group did their usability evaluation of the prototype in-person, while two participants completed it remotely (Moran & Pernice, 2020). The first session was also observed, to gain additional feedback from participants, particularly comments while playing, body langue and facial expressions.

The second session was not observed, as it was assumed that the participants would be able to navigate the prototype game easier than during the first time playing it. After playing the participants submitted an image of their results, as this was needed to compare with the data collected from the first session.

The participants were given the following user tasks for the evaluation:

1. Start the prototype game.
2. Follow the output from the game to enter the building.
3. Complete first quest.
4. Complete the second quest.
5. Take the elevator.
6. Complete the final quest.

During the user evaluations data regarding total time spent, times they used hand sanitizer, times they washed their hands, and how many times they failed at social distancing, were collected. The observations were also to locate pain points in the user experience, serious issues within the digital prototype, unexpected choices or solutions that needed addressing, and to see how the participants choose to navigate the play-area in the prototype and their responses to occurring situations.

4 Solution

4.1 Game Design Concepts

The prototype development began with ideation, and once a conceptual idea was decided on, the process continued by creating a storyboard to visualize the idea so far. The storyboard creation was then paused while a low-fidelity paper prototype was developed to test some of the intended functionalities (Nielsen, 2003). After some testing with the paper prototype, the storyboard was completed, and was a useful tool when the creation of the digital prototype began.

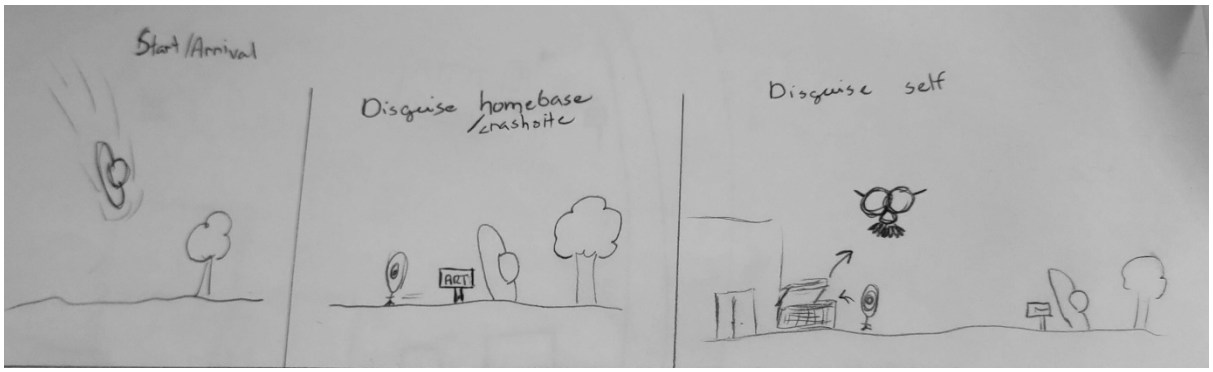

Image 4.1: The first part of the storyboard. Here the beginning is shown, until the character enters the building.

The low-fidelity paper prototype helped to discover potential functionalities or ideas that have not been thought of yet. It was also useful for the early evaluation of the game interface, and other UI elements suggested for implementation.

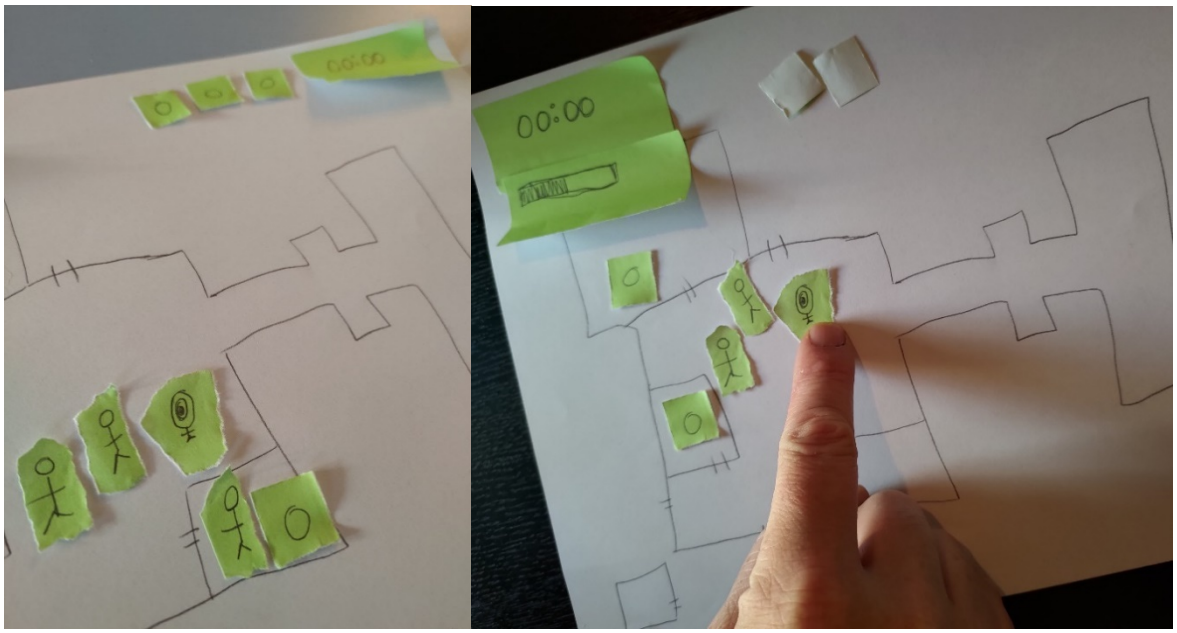

Image 4.2: Images from when the paper prototype was used to evaluate potential functionalities for the game.

4.1.1 Overall Design Concept

The game area is loosely based on the layout of the UiA campus in Grimstad. As the prototype was developed based on the same contents as part of the UiA (2020b) course, "*Training in Protective Measures*", and the target group is students, this was a way to bring the scenarios explored in the prototype a little closer to the player despite the fantasy aspect to the storyline.

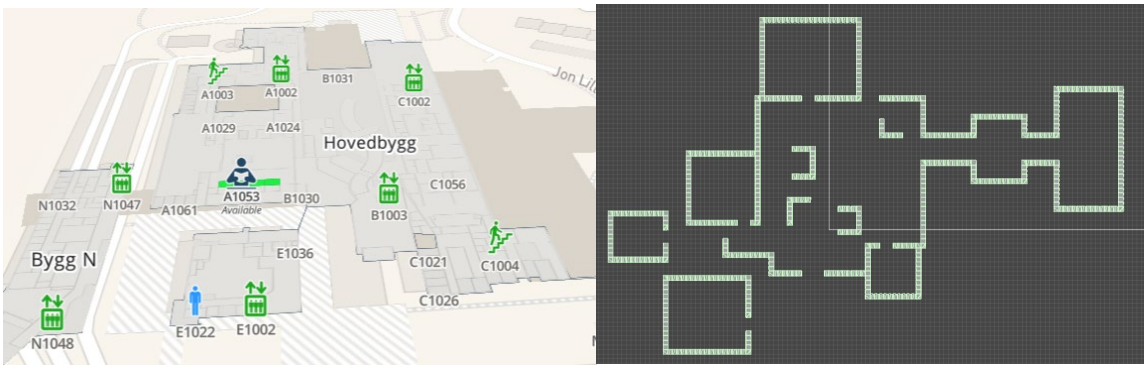

Image 4.3: Map of Grimstad Campus at UiA (left)(UiA, 2021);,Map of the game prototype (right), with other assets hidden. These maps are not identical, but similarities from the real campus have inspired the areas and rough shape of those in the prototype.

The prototype created for this project had a serious use in mind when being developed, but even "serious games" need to be entertaining at some level to be beneficial for its intended use. Hunicke et al. (2004) wrote about eight types of fun when describing the aesthetics of a game and applying these to the context of this prototype can be useful when developing. *Fantasy*, *Narrative*, *Challenge*, and *Submission* are the types of fun that are reflected at some level in this prototype. If worded differently, this means that the game is make-believe, drama, obstacle course, and pastime. With a main character, controlled by the player, in the form of an alien that have stranded on earth after a crash landing, and now must achieve certain tasks while avoiding getting close to humans, these descriptions can be fitting for the prototype of the game.

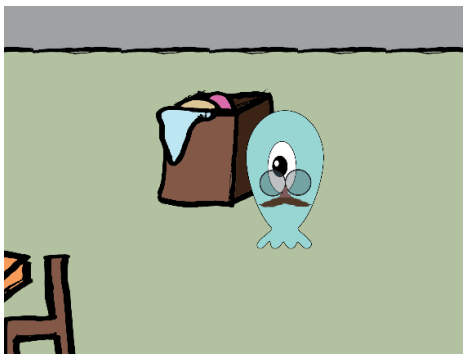

Image 4.4: Here the playable character is close to a box containing the list needed for the next part of the quest. This location is inspired by where the library is located at the UiA campus.

The quests the player must complete are not related to the scenarios of the game, but rather a story driving the player to the needed areas, while the educational aspect of the prototype is in the background. The player receives some information from the main character along the way, but when it comes to practicing hand washing or social distancing, they must also read signs and explore themselves as well. The items the player must locate are all placed in similar boxes, spread across the playing environment. As the prototype is loosely based on the UiA campus in Grimstad, the objects are also placed in areas that in some way remind of the real campus. An example of this is how the player must visit an area near the cafeteria to collect a potato.

It might be hard to figure out where to go with the limited information presented, however, the prototype is designed to make the players look around and not find everything immediately. To help guide the player to the correct path, placing road signs was considered, as well as arrows on the floor, but to not give everything away at once a flare to guide the path was added instead. The flare runs along a Bezier-path (Lague, 2019), and when it reaches the end of the path, it restarts. The speed of the flare is set to be close to the run speed of the player, but it is not always easy to keep up with as it only leads to the correct rooms, and not all the way to what is needed to collect.

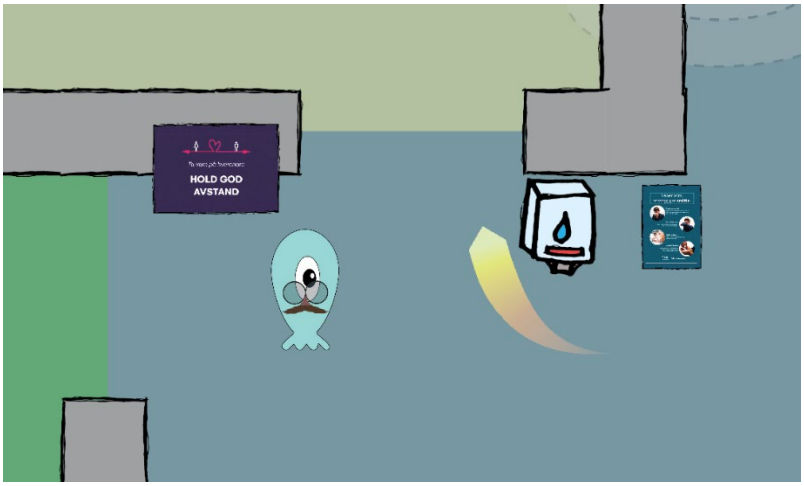

Image 4.5: Here we can see the guide flare helping the player locate the library.

4.1.2 Scenarios

The prototype of the game was developed with three different hygiene precautions scenarios in mind.

Image 4.6: Here the player (alien) is too close to the NPC (man). This action count towards the number of times the player fails at social distancing.

- Social Distancing
- Hand Hygiene
- Crowded Areas

In the prototype, social distancing is represented by the Non-Players Characters (hereafter abbreviated as NPC) in the game. To help the player navigate whether they are to close or still have room to move, the NPCs have an indicator placed at their feet. If the player collides with this indicator, they will gain additional infection. To give the player some hints as to what to do, or in this case what not to do, different signs have been scattered around the playing area.

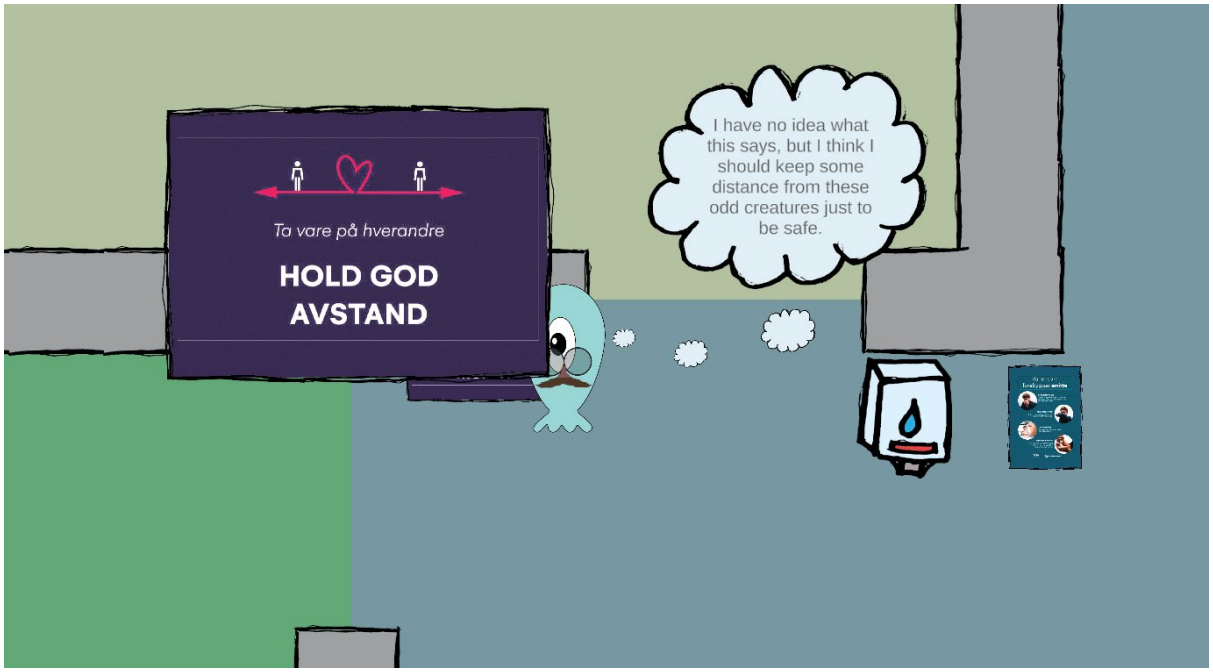

Image 4.7: A sign placed in the prototype of the game to let the player know that they should keep distance. The sign is an edited version of a "Keep distance"-sign from SiA (2021).

Image 4.8: Another sign used in the prototype, this sign is placed near sinks and hand sanitizers, in addition to proximity to entrances. This is an edited version of the poster "Habits that prevent infections" from Folkehelseinstituttet and Helsedirektoratet (2021).

The scenario regarding hand hygiene was based on the playing doing preventative actions in the game to keep their infection bar low. Some of the most important part everyone can do to help reduce the spread of infectious diseases, is to practice proper hand hygiene (Folkehelseinstituttet, 2020). To practice this within the prototype, hand sanitizer boxes are placed near entrances and other high traffic areas. In addition, the signs regarding hand hygiene are often placed near these. The sinks are not as commonly placed, but these also have the informative sign in near proximity. This was done as such to mimic how people are used to

finding hand sanitizer when visiting public areas, and to guide them to apply this action within the prototype.

Image 4.9: The scenario for crowded areas was represented by an elevator in the prototype To give the player a hint to how to decide when to enter, a sign to the right illustrates that only two people are allowed in at the same time, this sign is an edited version of a poster shown in the UiA (2020b) course "Training in Protective Measures".

In the elevator scenario, the player can open and close the doors as many times as they wish, and each time the elevator opens with 1 out of 4 random scenarios. The possibilities are two NPCs inside the elevator, an empty elevator, and two scenarios with one NPC in the elevator. Should the player decide to enter the elevator when there already are two NPCs within it, a substantial increase in their infection bar will occur.

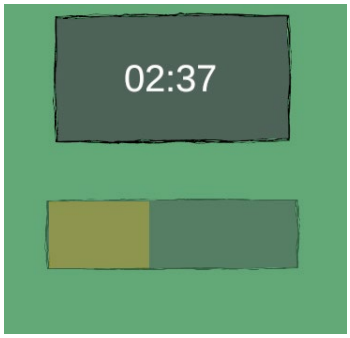

Image 4.10: Displaying time spent playing after entering the building (top), and the infection bar (bottom).

Time was added to measure how quickly the participants in the test group was able to solve the tasks in the prototype, as well as a comparable data to use to compare the user tests from the first time playing with the second time playing to see any changes in how quickly participants in the test group solved the tasks.

The infection bar is visible beneath the time, as shown in image 4.11 and will increase over time and when certain events happen. The infection bar is set to a maximum of 500 points, and a minimum of negative 10 points to counter over use of handwashing or hand sanitizer. The player will gain 1 point each second, i.e., if the player plays for 2 minutes and no other actions that can add or remove infection point occur the player will then have 120 points in the infection bar. The bar will also add a set amount of points each time the player fails at social distancing by getting too close to an NPC or take the elevator when there are two persons inside it, the number of points in the infection bar will decrease when the player washes their hands at a sink

or apply hand sanitizer. If the bar becomes full, nothing will happen, the bar was added to motivate the player to take action to avoid gaining infection. A possible use that was considered early in the planning of the solution, was to also add a quarantine scenario that would be active if the bar became full, but this idea was selected away due to limitations.

4.2 Implementation

The graphics used in the prototype are all created by myself for this project. Except for the aliens, main character and the arrived help at the end scene, everything was first sketched by hand, then digitalized using Adobe Illustrator, before being coloured and edited to reach the final version that are used in the prototype of the game. The two aliens were drawn in Adobe Illustrator only.

When the digital prototype was developed, several tools were needed. As mentioned previously, Adobe Illustrator was used to digitalize the handmade sketches. Adobe Photoshop was considered, but after some small tests, the choice fell on Illustrator for the entire digitalization process. Images created was exported as PNG files, before being imported to Unity to be implemented within the prototype.

The needed scripts for the prototype were written in the programming language C#. The prototype contains 18 different script files, each of them created for a specific purpose, such as controlling the camera when the player moves, running the elevator scenario, collecting statistics regarding time and other collected data.

When the prototype was ready, it was built as WebGL. The build of the prototype was then uploaded to Itch.io (itch.io, 2021) and made available to the users by entering a provided password and URL.

5 Results

During this evaluation, the control group participated by taking the first three modules of the course, "Hand wash," "Coughing hygiene," and "Keep distance," in addition to a pre- and post-questionnaire. The control group only partook once for the evaluation. The participants evaluating the developed prototype of the education game were asked to partake twice. For these participants, the second time playing through the prototype, they only filled out a post-questionnaire at the end in addition to submitting a screenshot or image of the final scores obtained when playing.

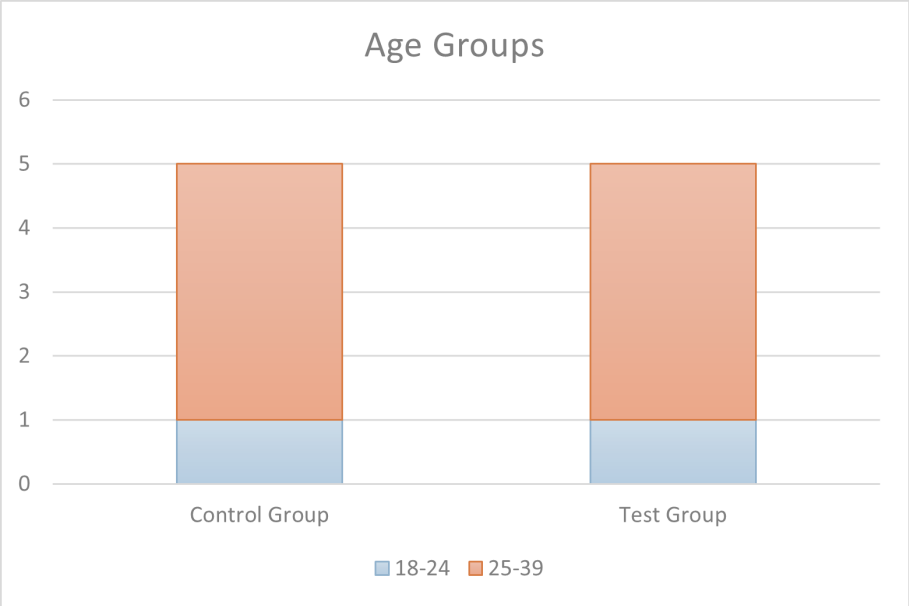

Figure 5.1: Age groups represented in the Control Group and the Test Group. Age's categories were based on the Norwegian governments COVID-19 age categories.

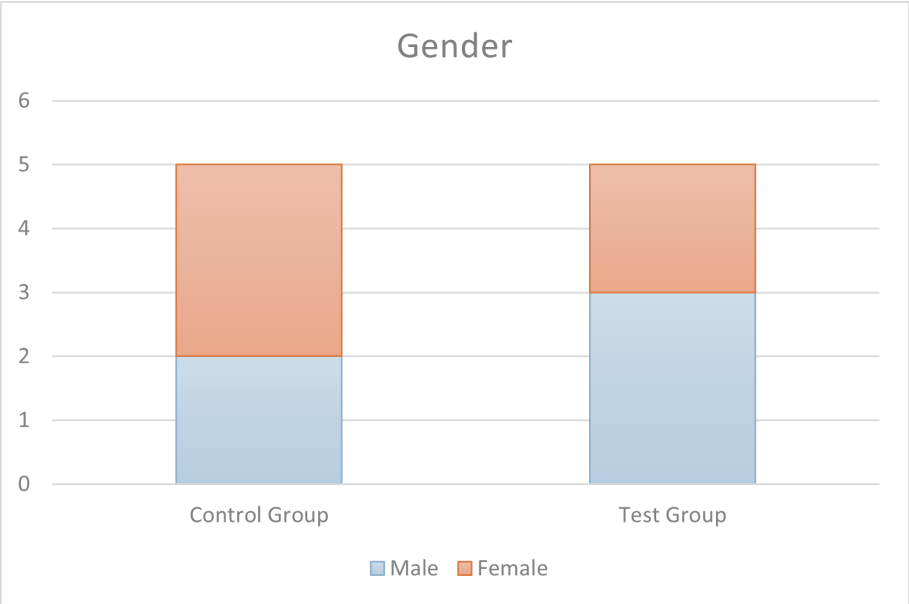

Figure 5.2: Gender division in the Control Group and the Test Group.

In the pre-questionnaires for both the control group and the test group, some general information about how the participants evaluated their own knowledge and ability to adapt to changes in hygiene rules was asked. These questions were asked with a 5-point Likert scale, and as illustrated in the figures below the answers were mostly positively noted as the participants answered either "Agree" or "Strongly Agree" when asked about their knowledge and understanding of the COVID-19 hygiene rules. When asked about their ability to adapt to rapid changes in hygiene guidelines and recommendations, 2 out of 10 participants answered "Disagree", one from the control group and one from the test group.

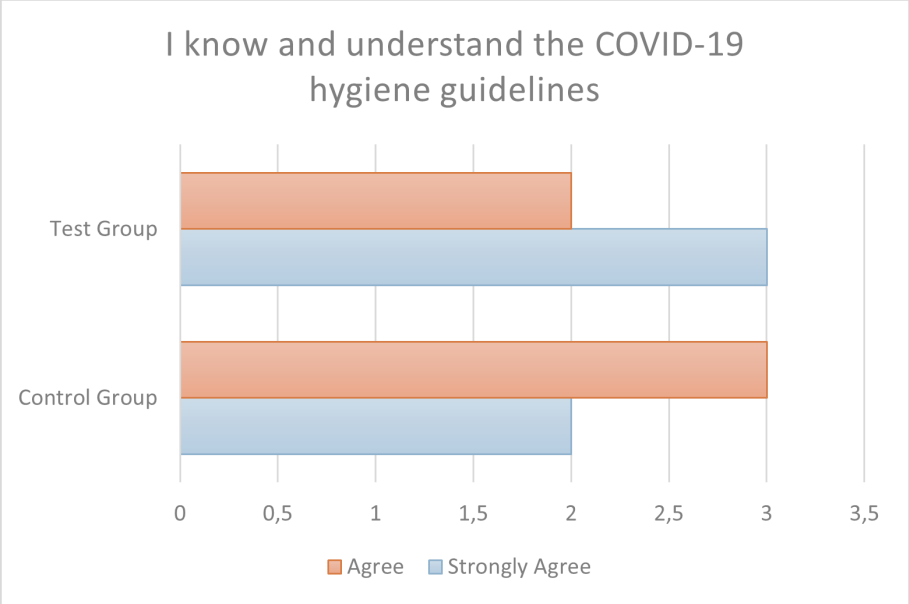

Figure 5.3: Question 4 from the pre-questionnaire for both the control group and the test group.

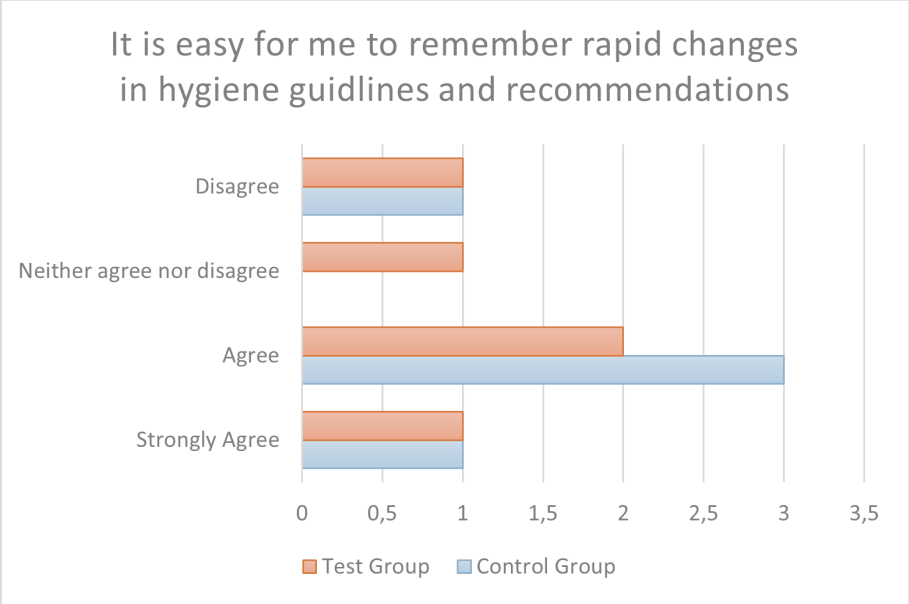

Figure 5.4: Question 5 from the pre-questionnaire for both the control group and the test group.

5.1 Prototype Evaluation

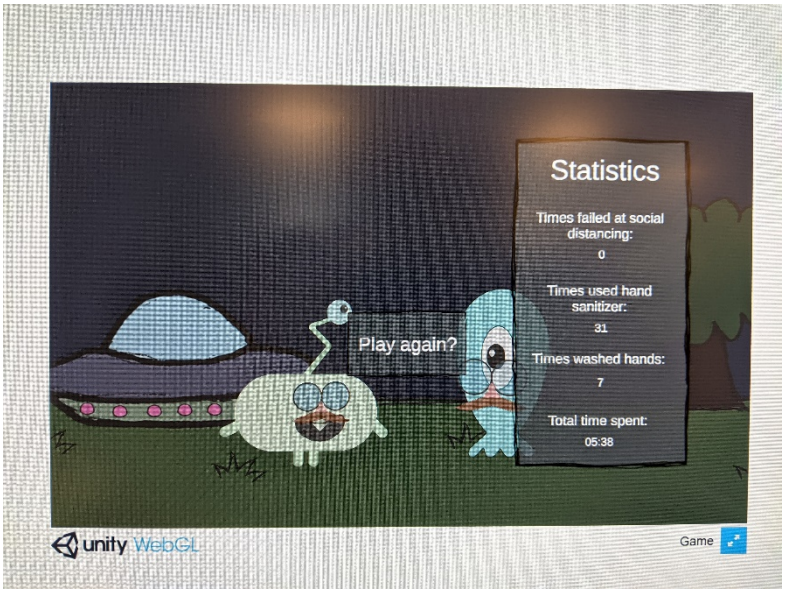

Image 5.1: Example of an image provided by a participant during the user evaluation of the prototype, here showing the results after playing.

To evaluate the developed prototype of the educational game, five participants were chosen to play through the game, in addition to filling out a questionnaire before and after conducting the user evaluation. To review potential learning outcomes from playing, statistics regarding how many times the participant washed their hands, used hand sanitizer, or got too close to an NPC, in addition to how much time they spent from start to finish. The results from the user evaluation had varying results for each participant, i.e., when it came to how many times the participant came to close to an NPC one participant had 0 at the end, while the highest amount was 26.

Table 5.1: Participants results from the first user evaluations of the prototype. Here positive actions, such as hand washing, are displayed in green shades, while negative actions are displayed in red shades.

	P1	P2	P3	P4	P5
Total Time	09:31	08:16	06:12	08:07	05:38
Failed at social distancing	2	8	6	26	0
Times washed hands	23	2	2	13	7
Times used hand sanitizer	17	18	9	11	31

In Table 5.1 above, results from the play test are shown for each participant, and the difference regarding the collected game data is large for the various categories, such as how the participant handles social distancing, or their choices in regard to using hand sanitizer or washing their hands when passing by the possibilities to do so.

The prototype was tested two times by the same participants, the second time approximately between one and two weeks after the initial test. This session was not observed, but the participants instead submitted an image with their different scores from playing through the prototype. As seen in Table 5.2 below, there was some improvement from the first time the participants played. For example, if we look at participant number 4, the first test had 26

instances where they failed at social distancing and walked to close to an NPC, while the second test they only walked to close to an NPC 7 times.

Table 5.2: Results from the second time participants played through the prototype. When comparing the variables from the first session with the second, we can clearly see some changes with the players.

Test Session 2	P1	P2	P3	P4	P5
Total Time	07:26	05:59	03:26	05:35	04:54
Failed at social distancing	0	7	2	7	0
Times washed hands	1	5	0	4	30
Times used hand sanitizer	1	8	11	6	31

When comparing the two sets of results, we can see that some of the participants choose to wash their hands or apply hand sanitizer more often than the first time they played through the prototype, while other might do it less this time. All participants spent less time the second time playing and failed at social distancing less than during the first session.

During the observations when the participants chose to use the elevator also varied during both evaluations. Some waited until they found an empty elevator, while others got on the first option, even if it had two NPCs in it already.

5.1.1 Summary of the Prototype Evaluation

- Clear improvements on time spent to complete playing through the prototype.
- All participants had an equal or lower number of times failed at social distancing.
- Some participants washed their hands or used hand sanitizer more second time playing, other did this much less.

5.2 Core Elements of the Gaming Experience Results

When the Core Elements of the Gaming Experience (CEGE) questionnaire was presented to the participants conducting the user evaluation on the developed prototype, the four questions regarding sound and music were removed as the prototype did not have sound effects or music added to it. This meant that from the 38 questions in the CEGE, 34 of these questions were presented to the participants. With limited time to conduct the user evaluations, and a limited access to users due to the COVID-19 pandemic, the sample size is small with only 10 participants. However, under different conditions in regard to both time and accessibility to users, a larger sample with at least 20-30 participants would be ideal, as well a broader quantitative survey.

In Figure 5.5 and Figure 5.6 the values of the mean and median are compared, as the size of the test group was limited, the value of mode was not significant for this evaluation. This was calculated based on the 5-point Likert scale questions provided to the participants, with the values ranging from 1, “Strongly Disagree”, to 5, “Strongly Agree”.

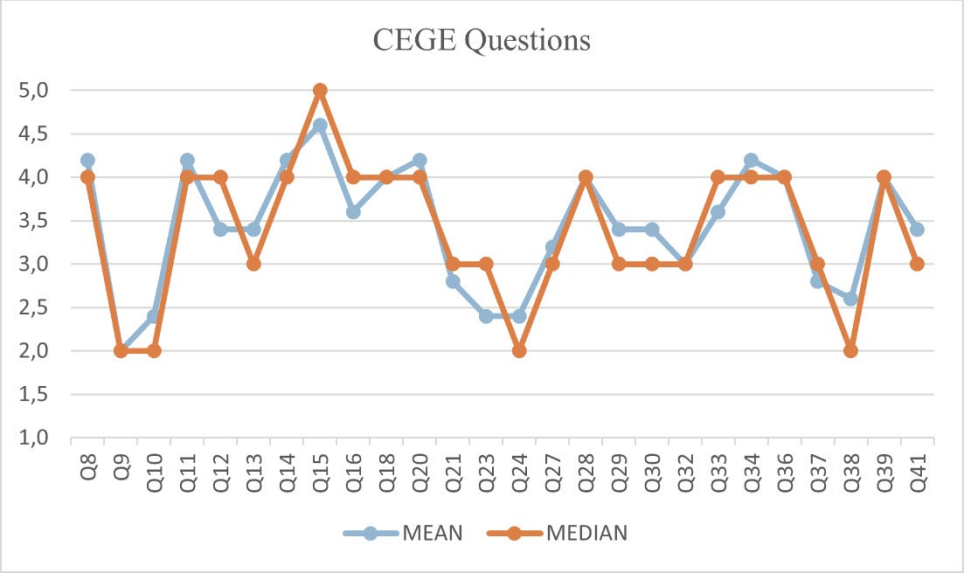

Figure 5.5: Results from CEGE questionnaire showing the mean value and the median value.

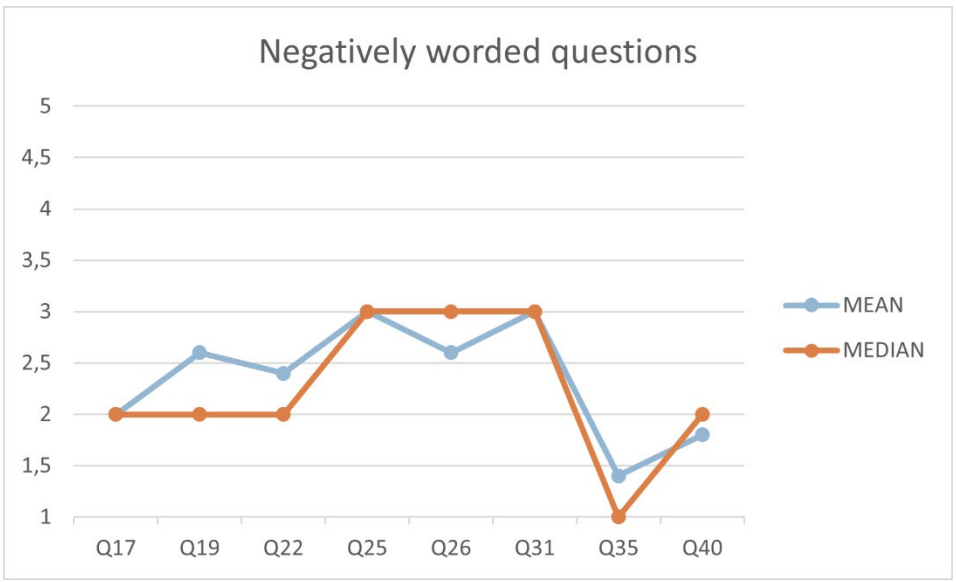

Figure 5.6: The questions from the CEGE that was worded negatively, here comparing the mean value and the median value.

The statement "I enjoyed playing the game" (Q8) had SD of 0.4, and as seen in Figure 5.5, this statement scored 4.2 on the mean value. This statement had min value of 4, and max value of 5, as 4 out of 5 participants selected "Agree" to this.

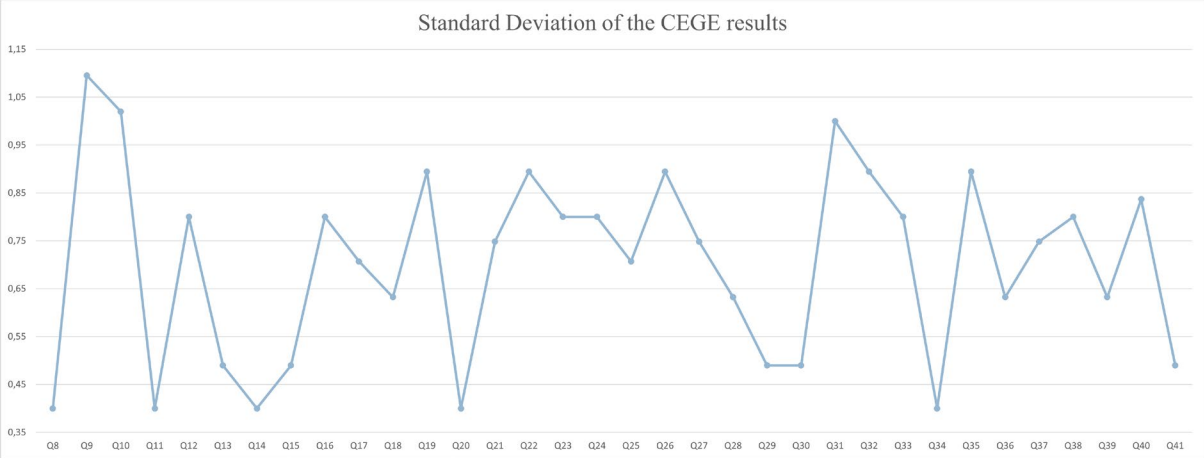

Figure 5.7: When examining the SD of the results from the CEGE, the numbers change greatly in some cases.

When studying the graph in Figure 5.7, we can see how the participants are largely in agreement with some statements, while on others the results are more divided. "I was frustrated at the end of the game" (Q9) had an SD of 1.1, thus indicating that the participants have selected their responses in a wider range. This statement had a min value of 1, "Strongly Disagree", and a max value of 4, "Agree". For this statement 2 out of 5 participants strongly disagreed, while 2 out of 5 agreed, and 1 out of 5 agreed with the statement.

The statements in the CEGE that are worded negatively, scored low on the Likert scale, while those that were not worded in a negative way scored higher. Some statements may be interpreted differently by different people or contexts, and this might sometimes influence the outcomes. An example of this is the negatively worded statement, "The game was unfair" (Q35), where 4 out of 5 participants strongly disagreed, while 1 out of 5 selected "Neither agree nor disagree". This gave this statement an SD of 0.8, and a min value of 1, and a max value of 3. Another example that was not worded negatively is, "The graphics were appropriate for the type of game", that had an SD of 0.8, with a min value of 2, and a max value of 4. On this statement 4 out of 5 participants agreed to it, while 1 out of 5 disagreed.

Table 5.3: Showing the mean, median, and SD of all CEGE questions asked during the evaluation. Here the median and mean values are coloured in gradient from green (5), to red (1). SD is shown in blue shades, where the darker colour indicates a higher value, while the lower values have a lighter shade of blue. Note: Statement 33 accidentally got lost when creating this table, that statement was as follows "33: The graphics were appropriate for the type of game".

	MEAN	MEDIAN	SD
8: I enjoyed playing the game	4.2	4	0.40
9: I was frustrated at the end of the game	2.0	2	1.10
10: I was frustrated whilst playing the game	2.4	2	1.02
11: I liked the game	4.2	4	0.40
12: I would play this game again	3.4	4	0.80
13: I was in control of the game	3.4	3	0.49
14: The controllers responded as I expected	4.2	4	0.40
15: I remember the actions the controllers performed	4.6	5	0.49
16: I was able to see on the screen everything I needed during the game	3.6	4	0.80
17: The point of view of the game that I had spoiled my gaming	2	2	0.71
18: I knew what I was supposed to do to win the game	4.0	4	0.63

	MEAN	MEDIAN	SD
19: There was time when I was doing nothing in the game	2.6	2	0.89
20: I liked the way the game looked	4.2	4	0.40
21: The graphics of the game were plain	2.8	3	0.75
22: I do not like this type of game	2.4	2	0.89
23: I like to spend a lot of time playing this game	2.4	3	0.80
24: I got bored playing this time	2.4	2	0.80
25: I usually do not choose this type of game	3	3	0.71
26: I did not have a strategy to win the game	2.6	3	0.89
27: The game kept constantly motivating me to keep playing	3.2	3	0.75
28: I felt what was happening in the game was my own doing	4.0	4	0.63
29: I challenged myself even if the game did not require it	3.4	3	0.49

	MEAN	MEDIAN	SD
30: I played with my own rules	3.4	3	0.49
31: I felt guilty for the actions in the game	3	3	1.00
32: I knew how to manipulate the game to move forward	3.0	3	0.89
	3.6	4	0.80
34: The graphics of the game were related to the scenario	4.2	4	0.40
35: The game was unfair	1.4	1	0.89
36: I understood the rules of the game	4.0	4	0.63
37: The game was challenging	2.8	3	0.75
38: The game was difficult	2.6	2	0.80
39: The scenario of the game was interesting	4.0	4	0.63
40: I did not like the scenario of the game	1.8	2	0.84
41: I knew all the actions that could be performed in the game	3.4	3	0.49

On most of the statements, often 3 out of the 5 participants agreed in what options they selected, while 1 or 2 of the 5 participants selected otherwise. This, combined with a small sample of participants, led to interesting results in some areas. But this also made it clear where the majority of the participants found something to be well done, or where more improvements are needed to create something enjoyable.

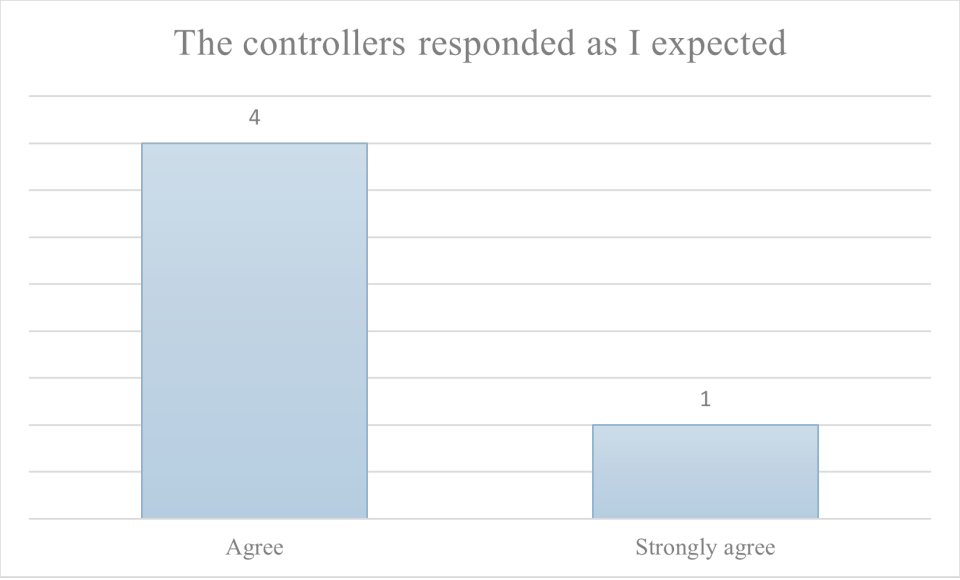

Figure 5.8: Q14 enquiring the participants regarding their experience using the controllers within the prototype. On this statement we can see that the participants were mostly agreeing to this.

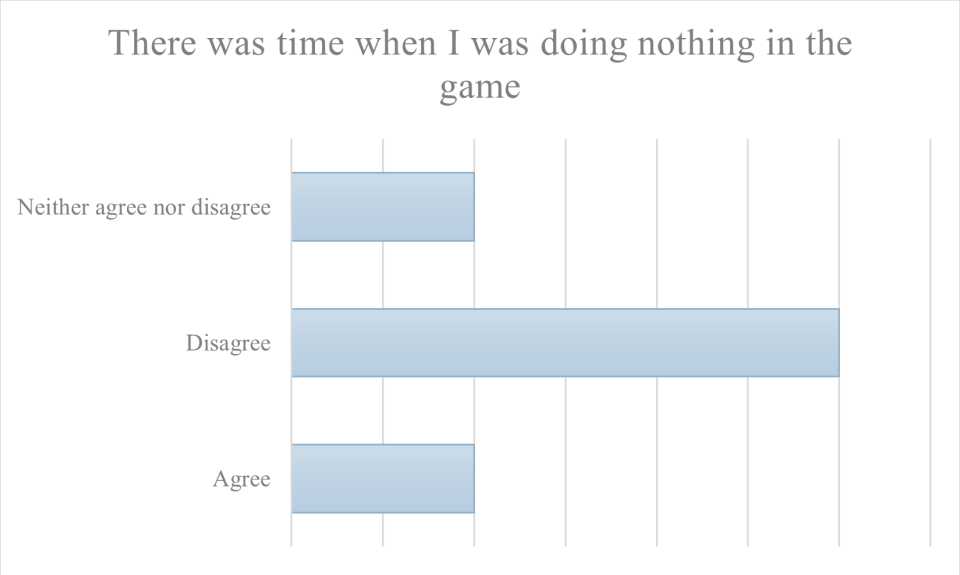

Figure 5.9: Q19 is an example where the participants are somewhat more different in their opinions. This statement had a mean of 2.6, and median at 2. SD = 0.89.

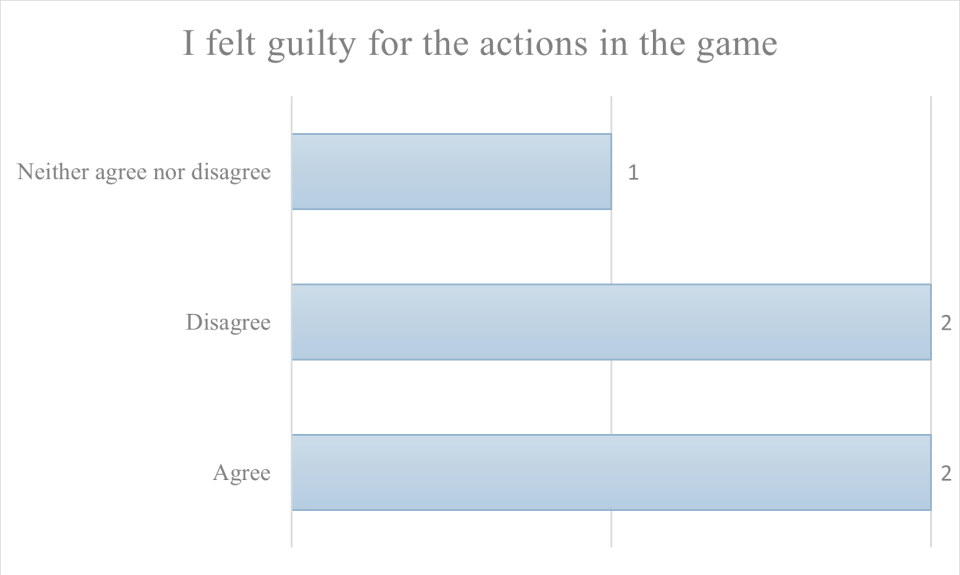

Figure 5.10: Q31, another example of a situation where the participants had different opinions regarding the statement. In this case SD = 1.00, mean = 3.0, and median = 3.

5.2.1 Summary of the CEGE Results

- The results seem to lean in a positive direction from the neutral option.
- The majority of respondents were often in agreement, with some exemptions.
- High mean value on items inquiring about enjoyment, while frustration was low.

5.3 Learning Outcomes

To measure a potential learning outcome from the prototype of the game, the same questions regarding disease precautions were provided to both the participants testing the prototype of the game, as well as the control group that tested the first three modules of the UiA course

"*Training in Protective Measures*" (UiA, 2020b). To evaluate whether the participants seemed to have learned something or not, identical questions were asked in both the pre-questionnaire and the post-questionnaire. The participants that evaluated the prototype also conducted a second round of testing, where they only filled out a post-questionnaire. The second session was not observed, and the participants submitted a screenshot or photo of their scores in the game to evaluate changes in their behaviour within the prototype.

The question "*How long should you wash your hands?*" had a recommendation of at least 20 seconds in the course taken by the control group. In the pre-test questionnaire 4 out of 5 of the participants in the test group answered, "30 seconds", while 1 out of 5 answered "1 minute". The post-test questionnaire the responses were similar with 1 out of 5 answering "1 minute", 3 out of 5 answering "30 seconds", and 1 out of 5 answering "20 seconds". On the second user evaluation the test group responded with 1 out of 5 answering "20 seconds". As for the control group on the same question, 3 out of 5 answered 30 seconds, 1 out of 5 answered 1 minute, and 1 out of 5 answered 20 seconds. This shows that in both the control group and the test group, all participants either claimed the recommended time of 20 seconds or suggested a longer time. No participants in either group claimed that the time spent washing one's hands should be shorter than recommended.

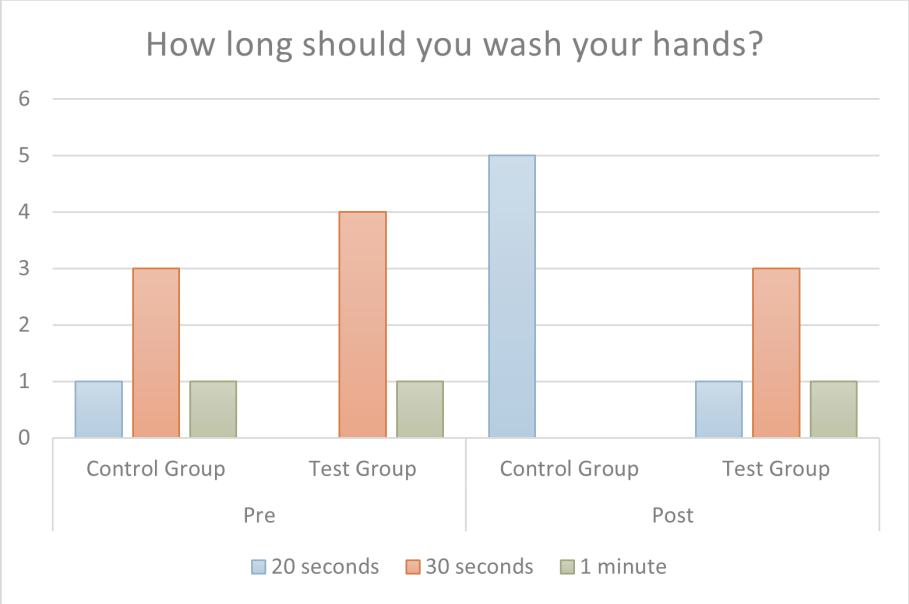

Figure 5.11: The difference in participants answers before and after conducting their test. This comparison shows the results from the participants evaluating the prototype's first answers.

When prompted about how much distance one should keep to other people, 4 out of 5 in the test group answered, "1 meter" in the first user evaluation, while 1 out of 5 answered "1.5 meter". After playing through the prototype for the game, 4 out of 5 answered "1 meter", while 1 out of 5 now answered "2 meter". As for the control group, in the pre-questionnaire 2 out of 5 answered "1 meter", while 3 out of 5 answered "2 meter". After taking the requested part of the course, 4 out of 5 participants answered, "1 meter", and 1 out of 5 still answered "2 meter".

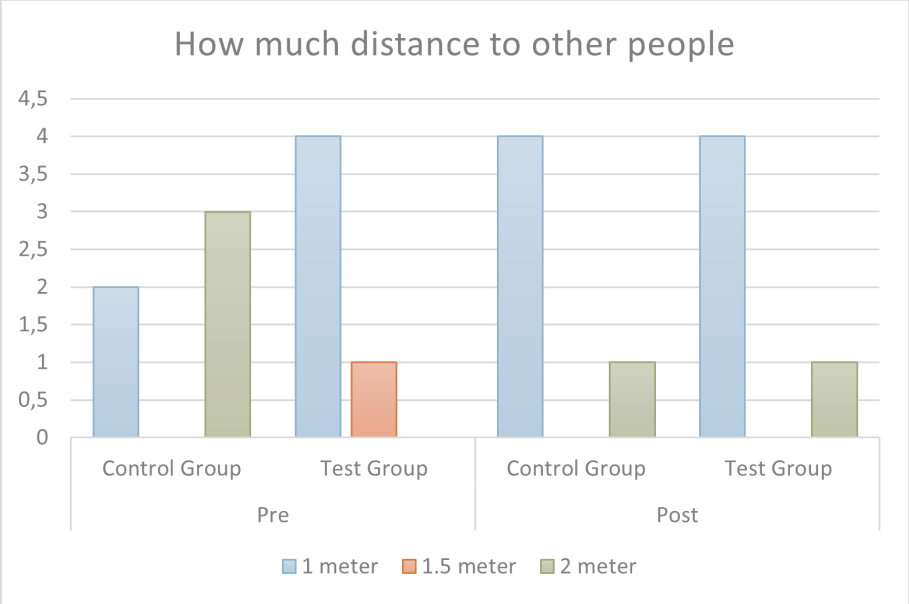

Figure 5.12: Comparison between question 8 from the pre-questionnaire, and question 3 in the post-questionnaire. For the test group, the post answers represent answers given the first time they evaluated the prototype.

The remaining questions were based on correct and incorrect statements. Below answers to the same question in the pre-questionnaire from the control group and test group are shown. In total both groups have the same number of incorrect choices picked, but the control group had more of the correct choices picked in total. As shown in the Figure 5.13 below, the control group had picked a total of 20 answers between 5 participants, where 18 of these where correct. In Figure 5.14 we can see the same responses from the test group, where a total of 19 options were selected between 5 participants, where 17 of these were correct.

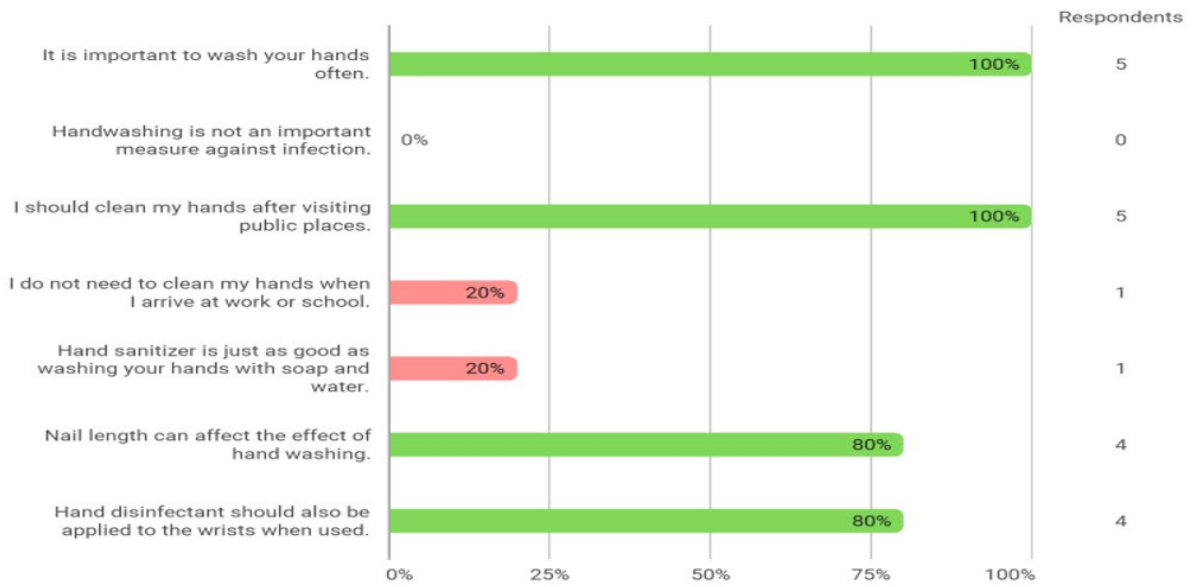

Figure 5.13: Pre-questionnaire answers from the control group where participants could pick multiple correct answers. Correct statements are shown in green, while incorrect statements are shown in red.

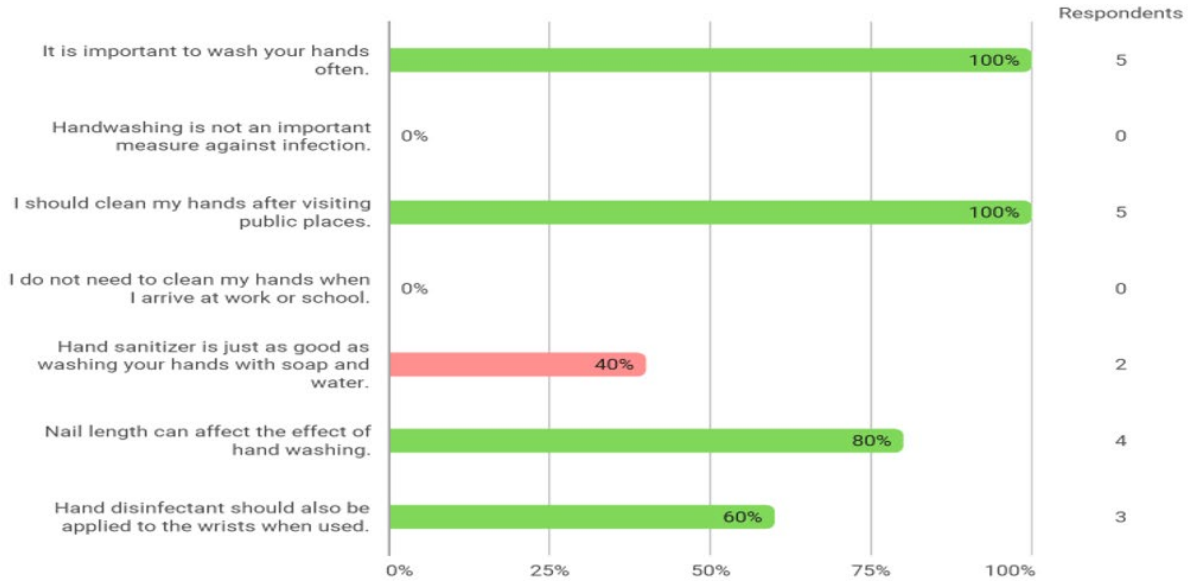

Figure 5.14: Pre-questionnaire answers from the test group, where correct statements are shown in green, while incorrect statements are shown in red.

In the post-questionnaires for both the control group and the test group, the selected options have changed. In the post-questionnaire the control group has selected 19 options in total between 5 participants, and all options selected are correct. The test group selected 21 options in total between 5 participants, where 20 of the selected options were correct, while one incorrect option was selected.

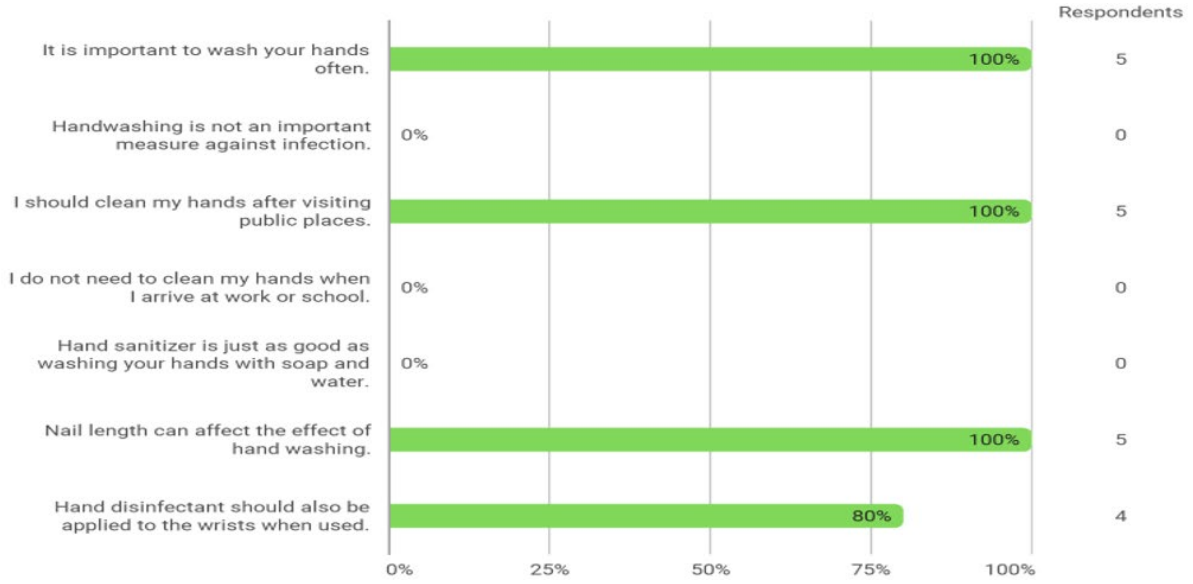

Figure 5.15: Results from the control group after the participants have taken the requested modules of the course. Correct options are shown in green.

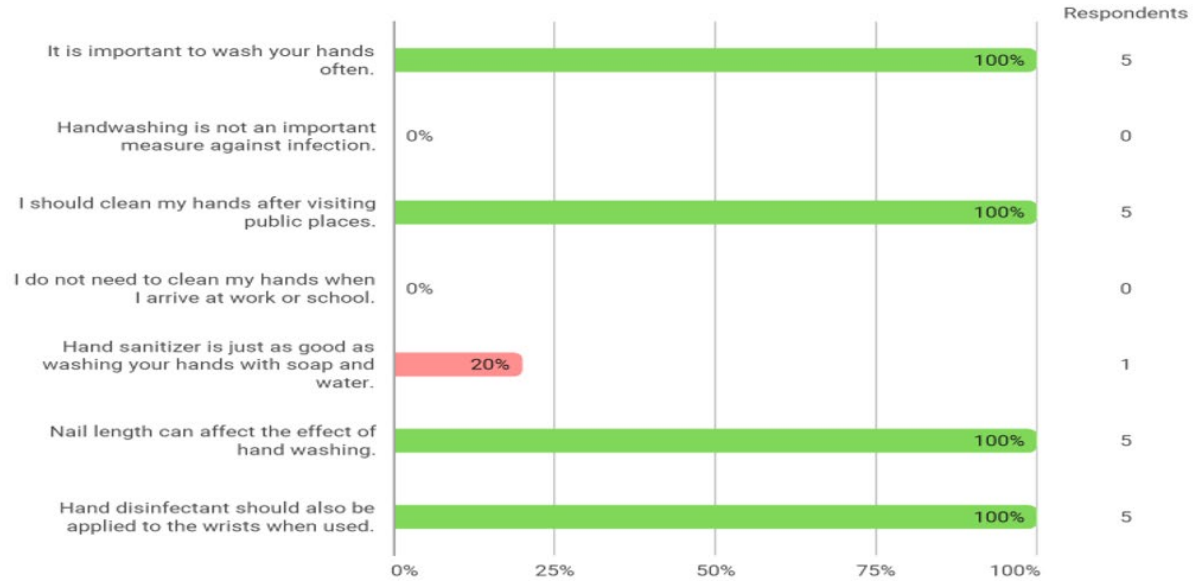

Figure 5.16: Results from the test group after their first time playing through the prototype. Correct options are shown in green, while incorrect options are shown in red.

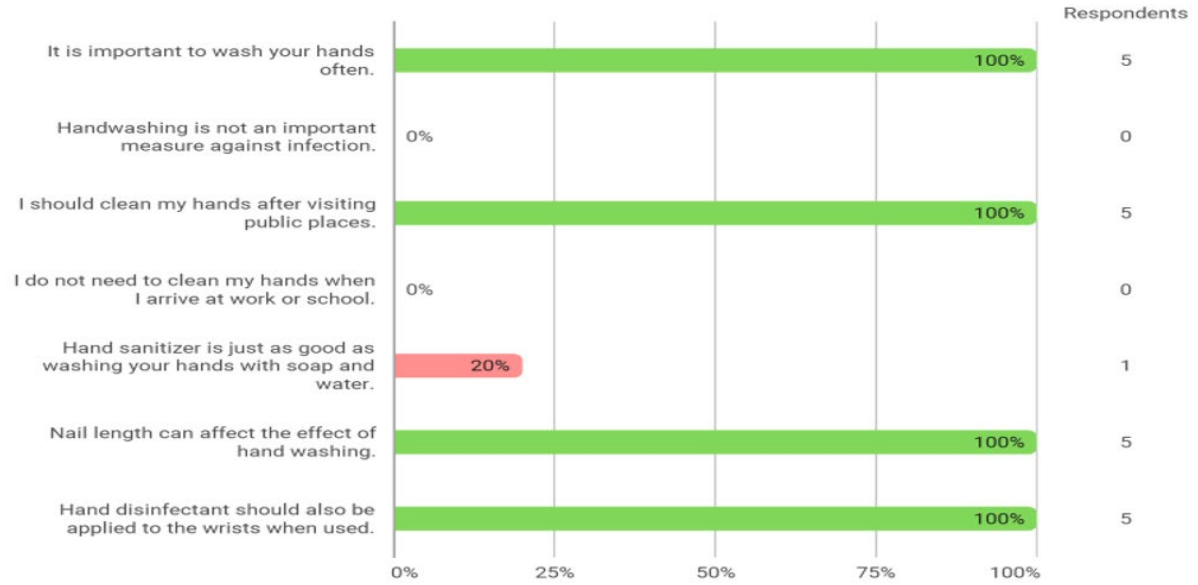

Figure 5.17: Results from test group after playing for a second time.

When asked about when it is recommended to wash hands in the workplace, 5 out of 5 in the control group selected the correct option in the pre-questionnaire. On the same question, 5 out of 5 participants in the test group selected the correct option in the pre-questionnaire. When the participants were asked this question again in the post-questionnaires, 5 out of 5 in the control group selected the correct options, and 5 out of 5 in the test group selected the correct option.

When participants were asked about what is important to think about when sneezing or coughing in the pre-questionnaires, 4 out of 5 in the control group selected the correct option. In the test group, 3 out of five selected the correct option. In the post-questionnaires, 5 out 5 participants in the control group selected the correct option, while 4 out of 5 participants in the test group selected the correct option.

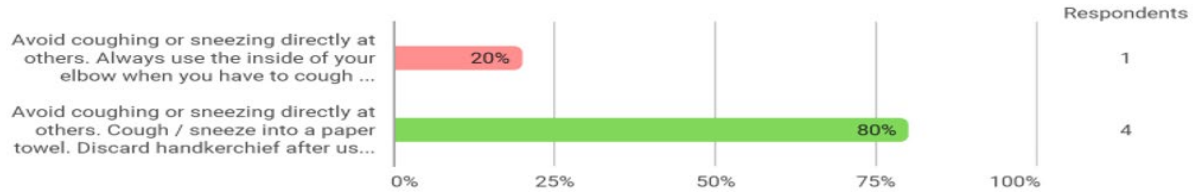

Figure 5.18: Control group answers from pre-questionnaire, correct option shown in green.

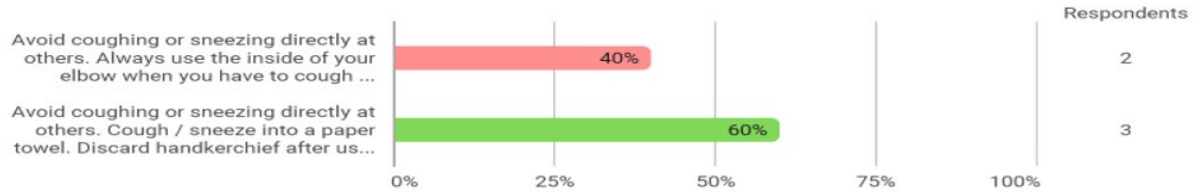

Figure 5.19: Test group answers from pre-questionnaire, correct option shown in green.

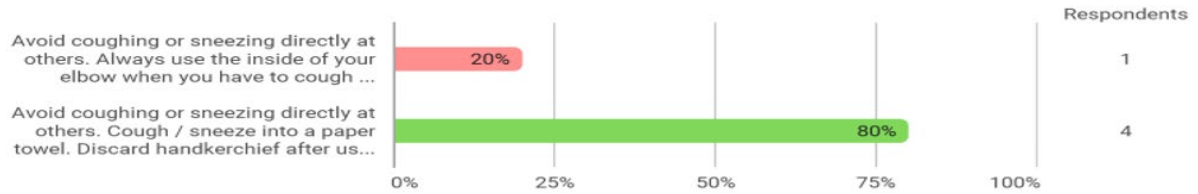

Figure 5.20: Test group results after second time playing, now 4 out of 5 selected the correct option, this result is equal to the result from the answers given after the first time playing.

The participants were also asked if they felt that their knowledge about hygiene precautions had improved after their participation, 2 out of 5 participants in the control group reported that they disagreed with that statement, 1 out of 5 agreed, while 2 out of 5 strongly agreed. The participants in the test group reported that 3 out of 5 agreed to this, while 2 out of 5 neither agreed nor disagreed with this statement.

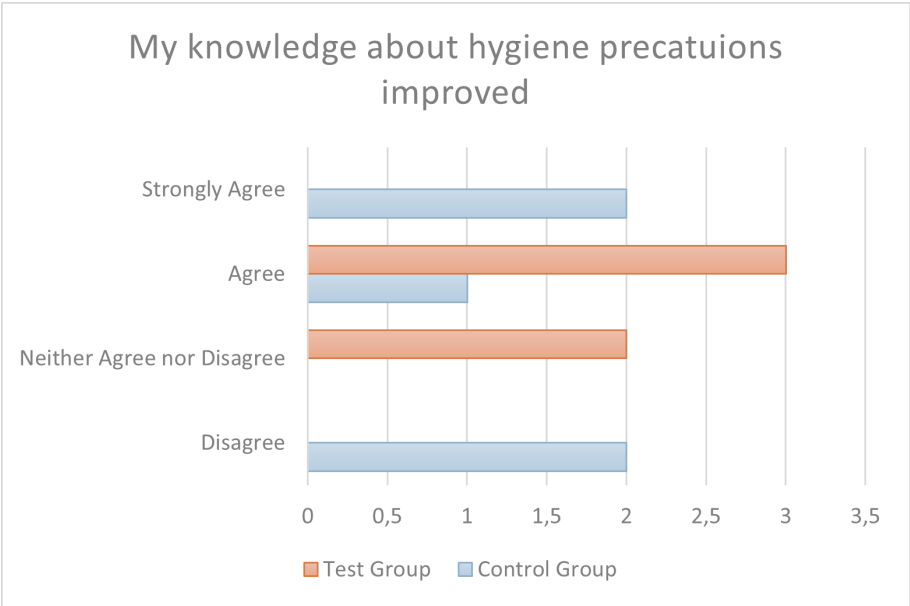

Figure 5.21: Participants were asked if their knowledge about hygiene precautions had improved after taking the course (control group) or playing the prototype of the game (test group).

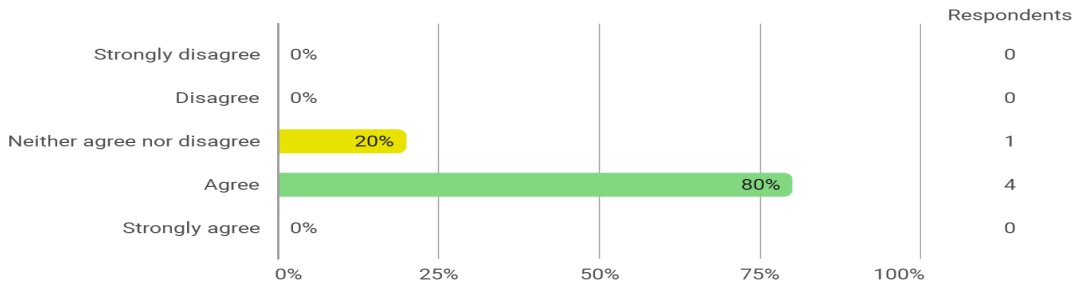

Figure 5.22: Test group, second user evaluation: Participants self-assessment.

5.3.1 Summary of Learning Outcomes

- Test groups self-assessment ranked higher the second time playing, but minor improvements to evaluate learning outcomes.
- Immediate improvement with control group.

6 Discussion

6.1 User Feedback Assessment

As the CEGEQ (Calvillo-Gámez et al., 2015) was used with a small sample size of five participants, the statistical relevance of the collected data is limited, but in this case use of the CEGE will give indications on what parts of the prototype had a positive impact on the gaming experience, and what had a negative impact. This information can provide useful feedback for future development of serious games in the context of educating users about preventing the spread of infectious diseases (Folkehelseinstituttet, 2020).

As the results have shown (

Table 5.3), the statements exploring **Enjoyment** (items 8, 11, and 12) scored on average (mean) 4.2, 4.2, and 3.4, thus giving the enjoyment-variable an average score of 3.9. As the Likert-scale used in this project is 5-point, this place enjoyment as agreeable. While the statements inquiring about **Frustration** scored lower with 2.0 and 2.4 means, and the average for frustration scored 2.2. As Calvillo-Gámez et al. (2015) writes, "*If the CEGE are present, then Frustration should be low and uncorrelated*". This shows us that the CEGE can be present at this point, as the frustration is low, and the enjoyment is high.

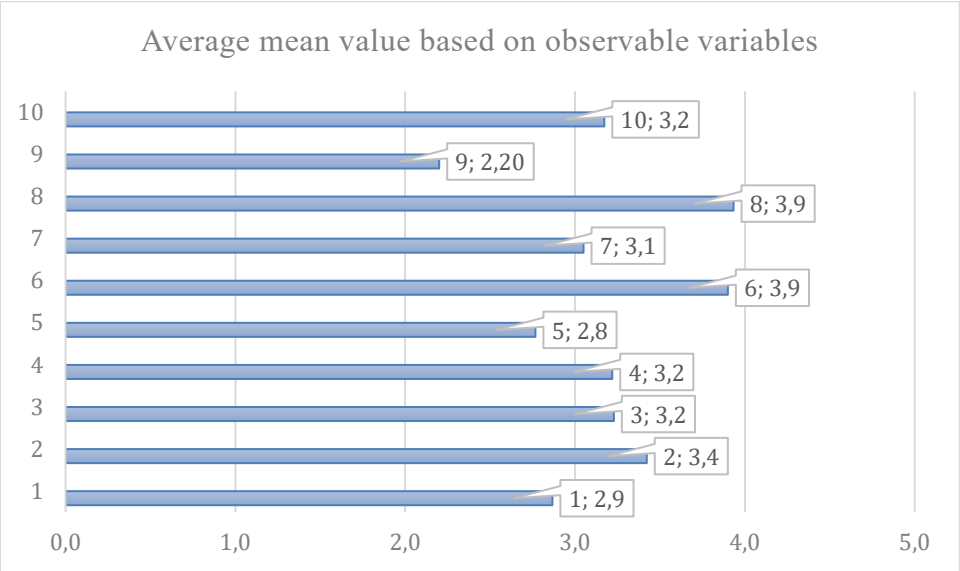

Figure 6.1:Average value of the different observable variables explored with the CEGEQ, this means the eight scales and the CEGE and Frustration in addition. Statements that are worded negatively is not retracted or change for the average shown here. 1: Facilitators, 2: Control, 3: Ownership, 4: Puppetry, 5: Game-Play, 6: Environment, 7: Video-game, 8: Enjoyment, 9: Frustration, 10: CEGE.

When calculating the CEGE, enjoyment and frustration have not been counted, as the CEGE is based on statement 6 till statement 38, or 34 in the case of this study. However, if we look more closely at the responses given to the CEGEQ statements, we can gain a lot of knowledge about what the participants liked, and what could be used further improvements. The statements "I remember the actions the controllers performed" and "The controllers responded as I expected", both scored well with the mean valued at 4.2 and 4.6, respectively. This shows that these functionalities are working well in the prototype now. The rules present follows the description from Salen and Zimmerman (2004), and of looking at the results the participants in the test group The rules present follows the description from Salen and Zimmerman (2004), as the prototype is digital we can relate how the rules are set to limit player actions, explicit and unambiguous, fixed, and repeatable, and how this can be related to the controllers of the game, and their functionalities such as limiting the run speed for the player as an example.

Some of the statements in the CEGEQ are negatively worded, and most of these statements scored relatively low among the participants, thus indicating that these had a positive impact on their experience of the prototype. An example of a statement negatively worded that did not score low, was "I felt guilty for the actions in the game," as this statement ended up a mean value at 3. During the observations, some of the participants mentioned that they felt a little

bad when they bumped into the NPCs by accident, while others did not seem to mind it that much. This can mean that the prototype provided the freedom for participants to explore and fail on their own (Nicholson, 2015).

This prototype was neither challenging, nor difficult, and as expected the score here was low. Depending on the persons playing, a game might need to be difficult to be fun, or easy games are preferred, and with that in mind this game is created with the intention to be feasible to most people. The main goal is not to be entertained by the game created in this prototype, but to provide a different way of learning that *might* be more fun than traditional methods (Nicholson, 2015).

From the results of the CEGEQ presented to the participants after the first time they played through the prototype, it is clear that they did not have a bad gaming experience (Calvillo-Gámez et al., 2015). As the CEGE cannot clearly state if the gaming experience was positive, we can see indications that the experience was mostly agreeable to the participants.

6.2 Learning Outcomes

The learning outcomes are an important aspect of the development and evaluation of the prototype, and the actual learning outcomes are the main part of that, it can also be interest to review the self-assessed impression of the potential learning outcomes from the participants.

Among the participants in the control group, 2 out of 5 disagreed to the statement "*My knowledge about hygiene precautions improved after taking the course*", while 2 out of 5 strongly agreed to this statement. For the test group after the first user evaluation, 3 out of 5 agreed to the statement, while 2 out of 5 neither agreed nor disagreed. After the second user evaluation however, this changed to 4 out of 5 agreeing to the statement "*My knowledge about hygiene precautions improved after playing*", as shown in Figure 5.22. Based on these results, we can see indications that the participants themselves thought they got a greater learning outcome by playing the game in the prototype, rather than taking the UiA course on the same subject, with the prototype as the more knowledgeable other (McLeod, 2018). However, with a small sample size these results are not conclusive, but they give an indication. Redoing the user evaluations with a larger sample size could provide interesting data regarding how the participants self-assess any potential learning outcomes in these two contexts.

When the participants in the control group were asked for how long they should wash their hands, 1 out of 5 in the pre-evaluation questionnaire gave the correct answer of 20 seconds, while the remaining 4 participants either answered 30 seconds or 1 minute. However, in the post-questionnaire all the participants in the control group gave the correct answer. The test group did not have the same opinion, as in the pre-evaluation questionnaire 4 out of 5 answered 30 seconds, while 1 participant answered 1 minute, resulting in none of the test group participants got the correct answer in the pre-evaluation questionnaire.

But when it comes to hand washing, it is better to answer incorrectly the way it happened during these surveys, rather than reducing the time one should spend when wash one's hands. But for

users to get a better grip of how long they should wash their hands for, the game would have to be designed to get this information across clearly. This could be accomplished by having a countdown timer when using the sink, thus forcing the player to wait for 20 seconds to gain a benefit. It could also be added more text to the game, with bite-sized information the player can find during their progression. In its current state, the use of hand sanitizer and hand washing is based on the user making a choice to do the action (Nicholson, 2015; Suppan, Catho, et al., 2020).

When it comes to social distancing, participants in both groups had improvements. In figure 5.12, we can see the 2 out of 5 in the control group answered 1 meter as the minimum distance to keep to other people, with the remainder of the control group claiming 2 meters, for the pre-evaluation questionnaire. While in the test group, 4 out of 5 answered 1 meter in the pre-evaluation questionnaire. But with the post-evaluation questionnaire, both the test group and the control group had 4 out of 5 participants answering 1 meter. After playing through the prototype for a second time, all 5 of the participants in the test group answered 1 meter.

The control group had a greater improvement in their answers to this question, but this might also be due to the control group having less correct answers selected in the pre-questionnaire. It is worth mentioning that although the recommended distance to keep to other people is set to 1 meter in Norway, it was for a while recommended to keep 2 meters distance during the spring of 2021. This might affect the answers provided by the participants, as changes in advice can sometimes be hard the always remember. Considering that the UiA course was created in 2020, and that the participants might practice different recommendations at their place of study or work, there are several factors that might affect the results in this case. When the evaluation with all participants in both the control group, and the test group, was conducted, the national recommendation in Norway was set at 1 meter, but some local areas might have set a stricter recommendation (Helsedirektoratet, 2020; UiA, 2020a).

When the participants had to select between different statements in a multiple-choice question, where there was 4 correct statements and 3 incorrect statements, both the control group and the test group selected the same number of incorrect choices within their respective groups during the pre-evaluation questionnaire. However, after conducting their respective tests, the control group selected 0 incorrect answers, but lacked 1 correct answer. The test group on the other hand had all participants select all the correct statements, but 1 participant also selected an incorrect answer. For the test group, the results after the first play-through and the second play-through were identical.

Image 6.1: The sign used in the prototype to inform about hand-, coughing- and sneezing hygiene. The quality of this is not readable for the smaller text, due to the quality of the original version.(Folkehelseinstituttet & Helsedirektoratet, 2021)

The incorrect answer selected after playing the prototype were "*Hand sanitizer is just as good as washing your hands with soap and water*" (Folkehelseinstituttet, 2020; UiA, 2020b). As this statement only were claimed in the test group in the post-questionnaires, the difference between hand wash and hand sanitizer in the game is not clear enough. This could be changed by changing the value of how many infection points is removed when applying either in the prototype, but from observing the participants during the first prototype evaluation, this might not be enough to help them remember. As suggested earlier, more text-based information could in this case also be useful to get the needed information to the users.

The final hygiene question given during the surveys, regarded sneezing and coughing. This topic was not directly covered in the game, but the information signs the players could interact with supplied information about this, as seen in Figure 6.1. However, the sign is not very readable with in the prototype, and as such did its content was not possible to view properly. This sign is however based on a well-known poster in Norway, that is displayed many places, often close to restrooms (Folkehelseinstituttet, 2020; Nicholson, 2015). This could be improved by using a higher quality version of the original poster.

Research Question 1 was as follows; *How different is a student's ability to remember, and implement, COVID-19 precautions at UiA in their daily life, depending on whether they took a course or played a serious game with the same teachings?*

With the small sample of participants, any difference can only provide indications in any direction. Based on the results collected during this study, the control group taking the digital course in "*Training in Protective Measures*" at UiA did improve their results slightly when directly compared to the test group. Both the test group and the control group showed overall improvements when comparing the pre- and post-questionnaire, but overall, the control group

had more correct answers. With some of the questions, both groups answered wrong in a more careful direction during their pre-evaluation questionnaires, such as washing your hands longer than the recommendation. Although the control group had a larger increase in correct answers, we can also see with the results from the test groups second time playing that they still had slight improvements, and their results did not worsen between the first and second time playing.

Research Question 2 was as follows; *How does an educational game affect the ability to remember teachings of COVID-19 hygiene rules and precautions over time in young adults in Norway?*

To get better insight to this question, with more trustworthy results, a large sample of at least 20 to 30 participants should be used, as the small sample of only 5 participants cannot provide any reliable data. However, the collected results from this project give an indication that an educational game can be a useful tool in teaching hygiene rules to young adults, as the participants responses did not worsen over time, but improved slightly. Redoing this with a larger sample of participants could provide better insight and interesting results, particularly if conducted with more play-sessions over a longer period. The evaluations and survey questionnaires show an indication toward a minor positive affect on the ability to remember the COVID-19 teachings presented during the evaluations, but it is not conclusive.

6.3 Scenarios and Observations

Through oral feedback provided during first playtests of the prototype, most feedback related to game design, wants, and needs within the game. During the observations, some issues with the prototype were present in several of the observed tests, particularly trouble finding the elevator, and getting lost on the outside of the buildings. The prototype design could have been clearer when it came to directions regarding quest locations, and especially the design of the elevator could have been improved further to be more recognisable.

Regarding navigating the play area of the prototype, it could have been beneficial to the participants to have access to a minimap to help them locate the areas needed. Alternatively, it is common in many digital games to have a map function larger than a mini map, such a function could also be useful to help guide and direct the player in the correct location for the item(s) or location needed to progress. To help the player navigated the area, the prototype had a small guide flare that ran on a path set by a Bezier curve (Lague, 2019), but this was hard to always follow. It was also considered adding road signs or arrows to the ground to indicate directions and adding a road sign in addition to the guide flare might have been useful for the participants, as both would only indicate directions rather than provide clear instructions that did not require any independent exploring.

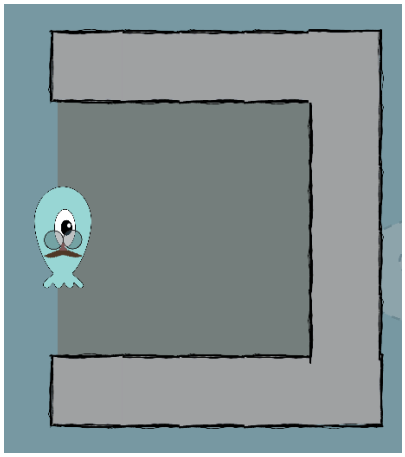

Image 6.2: The elevator as seen it the play area of the prototype.

As mentioned above, several of the participants struggled to locate the elevator their first time playing the prototype. Locating it seemed challenging as the visual design of it was seen from above within the game, and despite the attempt to hint the location with remarks from the main character, recognizing it was not easy. To help guide the player, but not help to much, the information from the main character was not directly stating what the participant was looking for, "*I think I saw a vertical aligned transportation device earlier somewhere in the middle of this humanoid hive*". There are several potential solutions to how one can improve the visibility of the elevator, for example the guide flare can be programmed to go from the players' current location to the next required location in a loop, the elevator could load and unload random NPCs in an interval to make the location clearer that something is happening there. The simplest solution might be to redesign the visual part of it, either by adding a common icon on top of the grey area the is recognisable to most people, or create a new asset to replace it, in such a case it might be better to move the entrance to the elevator to the bottom to take advantage of the way most angles and directions are used in the current 2D design of the other assets.

The scenario where the participants practiced social distancing by avoiding close contact with the NPCs, all participants during the observations in the first session seemed to mind and be careful where they decided to walk. In the first session the participants had an average of 8.4 times they got too close, but in the second session the average was down to 3.2 times. This major improvement might be due to one of the participants in the first session failing at social distancing 26 times, but when looking at the numbers for each participant, we can see that each one lowered the amount from the previous evaluation session.

Table 6.1: A visualised comparison between the first evaluation and the second evaluation visualising the relationship between time (measured in seconds) and the other scenarios. The results are visualised with colour to clearer illustrate the positive or negative weight, where those marked with "N/A" had "0" in that category. Each column represents a participant in order to review the individual changes in behaviour.

First Evaluation					
Failed at social distancing	285,5	62,0	62,0	18,7	N/A
Times washed hands	24,8	248,0	186,0	37,5	48,3
Times used hand sanitizer	33,6	27,6	41,3	44,3	10,9
Second Evaluation					
Failed at social distancing	N/A	51,3	103,0	47,9	N/A
Times washed hands	446,0	71,8	N/A	83,8	9,8
Times used hand sanitizer	446,0	44,9	18,7	55,8	9,5

As seen in Table 6.1, the collected data from the play tests of the prototype are measured to seconds per instance, as an example we can see how the first participant had 285.5 seconds between each time they got too close to an NPC the first time playing, but during the second session this participant did not fail at social distancing at all. As the time changed for all

participants, only reviewing the collected data would be misleading, as a shorter time playing could also lead to fewer chances to use hand sanitizer or washing of hands, as well as less time to bump into the NPCs. In the table above we can also see how several of the participants paid less attention to hand hygiene during the second evaluation, this indicates that changing some of the requirements in the prototype to force the player to pay better attention might be required. This can also be improved upon by using "buffs" in the game, an example can be that using hand sanitizer decrease or give immunity to infections for a set amount of time. Another idea could be to add a quarantine scenario, that the player enters when their infection bar reaches a certain amount, or alternatively the player gets moved back to the beginning if the bar becomes full.

6.4 Limitations

The limited time available to complete this project affected all phases of the project, from planning to analysing the results. This limitation affected how large sample size it was possible to work with for the control group and the test group, as well as time available to measure the learning outcomes over a longer period. The project focused on qualitative research methods, rather than quantitative due to this. There were also limitations regarding available abilities and resources, that affected the development of the prototype.

Due to these limitations, the project scope was reduced from the first project draft, and the number of scenarios evaluated in the prototype had to be limited, as well as areas of interest not directly related to the course had to be removed from the plan.

7 Conclusions and Future Work

In this thesis project a high-fidelity digital prototype for an educational game was created to evaluate how a serious game compares to a digital course, both focused on educating on the topic of disease precautions and guidelines. As originally expected, the discovered results provided indications, rather than evidence, regarding the topics explored during this thesis project.

By applying the CEGE questionnaire during the first user evaluation of the prototype, the participants provided useful responses regarding what was done well, and what could be used for further improvements, to create an enjoyable gaming experience. As the collected results were qualitative, a statistically relevant claim is not possible whether the CEGE is present or not. There are indications that the CEGE is present in the prototype, and it could be interesting to develop the prototype further as part of future research with a bigger test group and quantitative methods applied as well.

The observations of the first set of user evaluations showed how the test group quickly understood that they had to avoid getting too close to the NPCs, but the choices made in the remaining scenarios seemed to differ. Whether these choices were made intentionally or unconsciously, it was clear that the prototype of the game should be designed to integrate all scenarios purposely so the learning content can be clearer for the users when playing.

The first research question was based on comparing the digital course, "*Training in Protective Measures*" at UiA (2020b), to the prototype created for this project based on the same learning content. Here the control group that took the course had a slightly better improvement than the test group that played the prototype of the game. The slight difference when comparing the two groups might be due to the small sample of participants in each group. Repeating the evaluations with quantitative research methods to validate could potentially provide interesting results.

The second research question was to evaluate whether the test group improved their learning outcomes over time, and although the test group did well when evaluating their knowledge about hygiene rules both before and after their first user tests, there was a slight improvement after the second user test as well. This shows an indication that the proposed serious game can potentially be developed to a useful educational tool in the context of teaching hygiene rules and infectious disease precautions.

What was interesting though, is that with the self-assessment the test group was more confident to claim that their knowledge had improved after playing, while the control group had more differencing opinions after taking the course. There is no reliability or validity at this point to claim that young adults and students in Norway learn better by playing a game than taking a digital course with the same contents, or the other way around, but there are indications that both a digital course and an educational game can be useful in the same context.

7.1 Future Work

A foundation that can be used for future research has been created with this thesis project. When it comes to infectious disease prevention, there are several related topics that were not explored during this short timeframe, and there were several ideas that were not investigated further due to lack of time and ability. Based on the experiences made during this project, some suggestions and ideas can be useful for future research:

1. Exploring Additional Scenarios

The course, "*Training in Protective Measures*", at UiA (2020b) consisted of seven modules, and creating scenarios for the modules not used in this thesis project could provide more reliable and valid results when comparing learning outcomes between an educational game with a digital course. Some potential scenarios that were considered for this project were the use of face masks, public transportation, and quarantine. These scenarios can utilize in several ways, but the learning outcomes can be beneficial for users when they enter the UiA campus physically, as well as in their daily lives outside the University.

2. Indirectly Related Topics

It can also be worth exploring topics not directly related to infectious disease prevention, but also look closer at condition affecting people indirectly due to the COVID-19 pandemic. With isolation and reduced contact with other people, more people struggle with loneliness (Mental Health Foundation, 2020; Røde Kors, 2020) or stress caused by the current situation (CDC, 2020). Expanding the scope for an educational game to also teach and practice healthy habits or adding social interactions by creating a multiplayer option. A broader scope has the potential to create a more useful game, when taking the mental health conditions into consideration.

3. Methods and Related Areas

Using other methods and theories than those used for this project can create a better insight to the users. Especially motivational theories to investigate intrinsic and extrinsic motivation among users when comparing an educational game to a digital course could be interesting to explore further. An additional suggestion would be to apply other questionnaires that investigate gaming experience, such as the Gameful Experience Questionnaire (Högberg, Hamari, & Wästlund, 2019).

4. User Evaluation Conditions

A larger sample of at least 20 to 30 participants would be recommended to get valid and reliable results, preferable more. But a focus on collecting a decent amount of quantitative data, in addition to qualitative data, will provide a broader understanding of the users need, wants, and understanding of an educational game at several critical points in the development process. To evaluate in the different phases, the end user experience can also be improved. This can for example be done by holding focus group interviews and individual interviews to get a proper

understanding of the user requirements before starting the development, as well as conducting user evaluations and interviews at critical points.

5. Different Target Users

The target user group for this project was students and young adults in Norway but exploring a younger target group could be an interesting change. Part of the test group mention during the observed evaluation how they probably would enjoy playing more if they were younger, and so recreating the project with a target group around 10 to 15 years old could potentially show changes regarding learning outcomes, than with young adults.

8 References

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9 Appendices

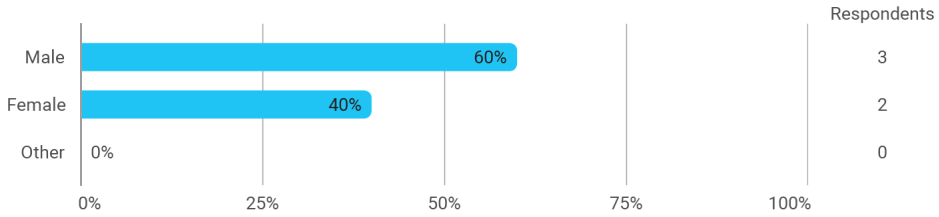
A. Result Details

The results added at 1.a), 1.b), 1.c), 2.a), and 2.b) are automatically generated reports exported from SurveyXact, as this was the tool used to collect responses to the survey questionnaires.

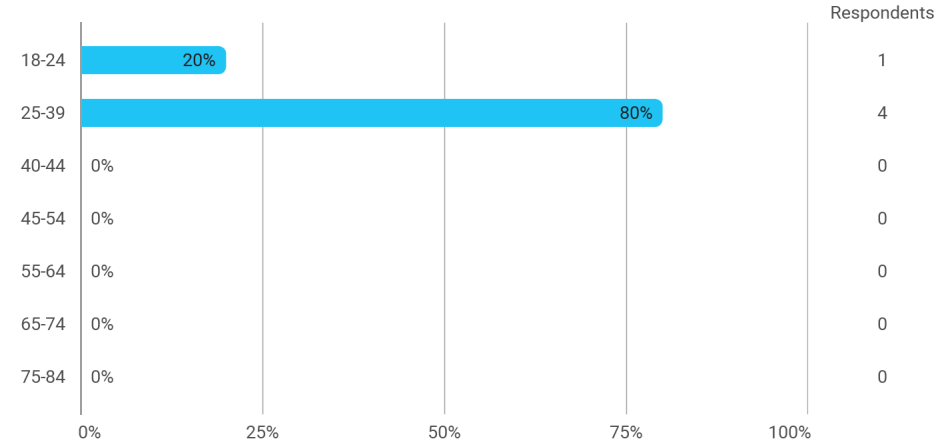
1. Test Group (Game)

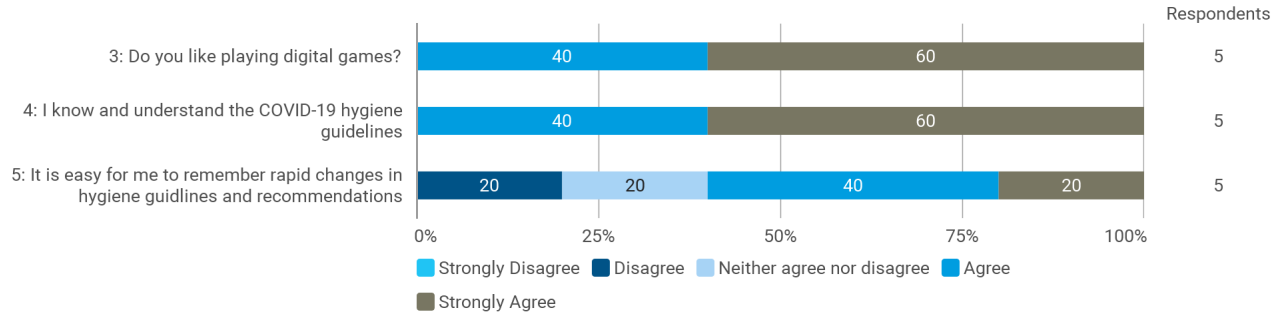
a) Prototype Evaluation 1: Pre-Questionnaire

1: Gender



2: Age



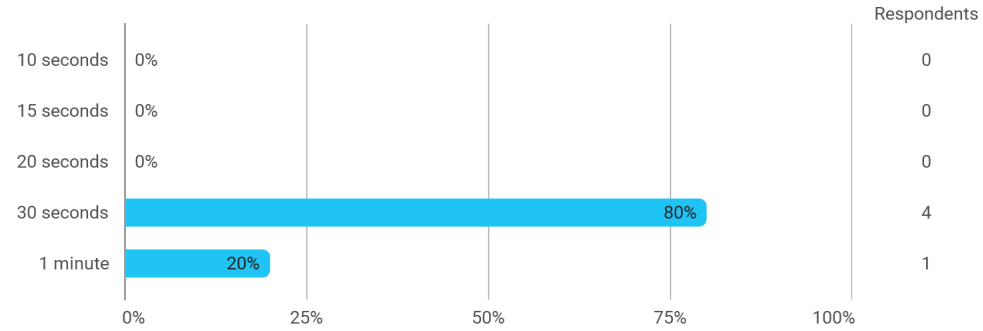


6: How/where have you learned about the COVID-19 hygiene guidelines during this pandemic?

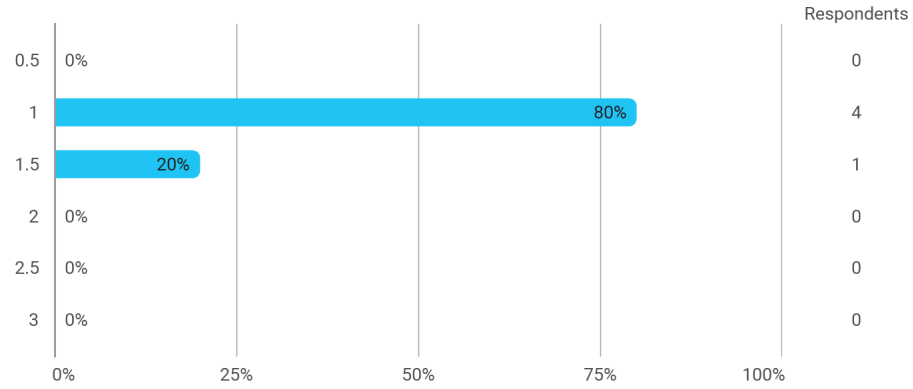
- My job.
- Nyhetene og bekjente
- News

- news, tv shows
- Through news and government guidelines.

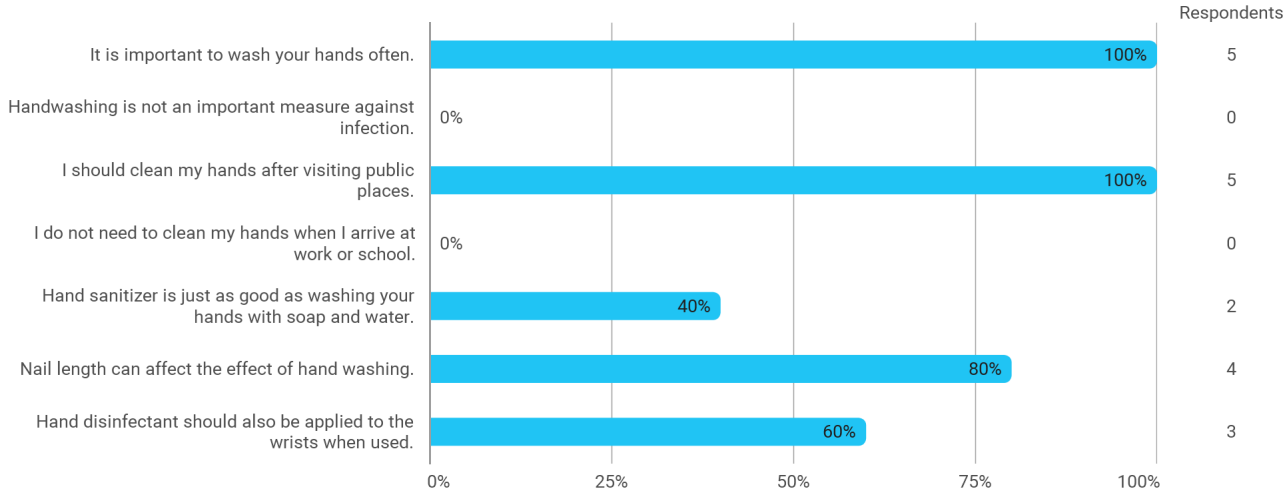
7: How long should you wash your hands?



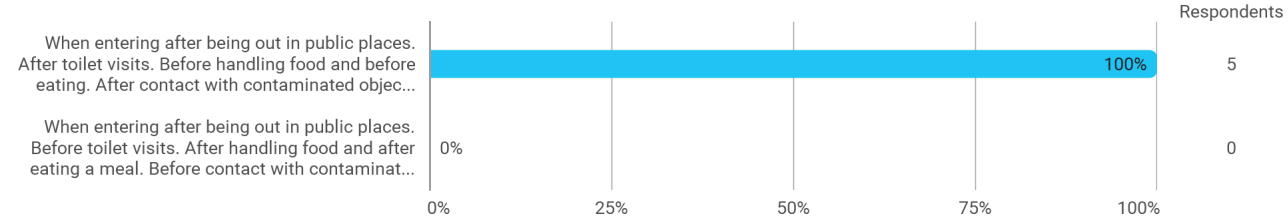
8: Keep _ meter distance to other people.



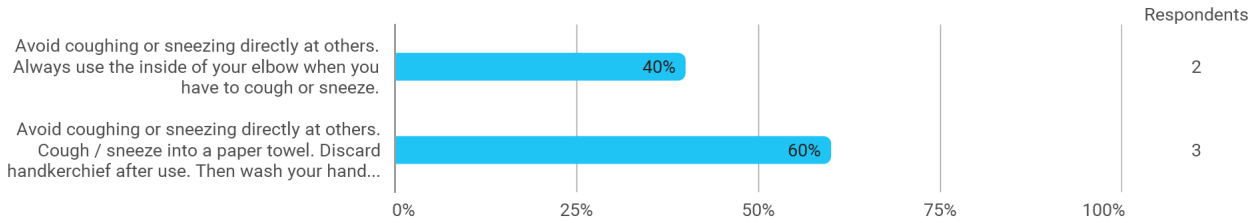
9: Which statements are true? (multiple answers can be correct)



10: When is it recommended to wash your hands in the workplace?



11: What is important to think about when coughing or sneezing?



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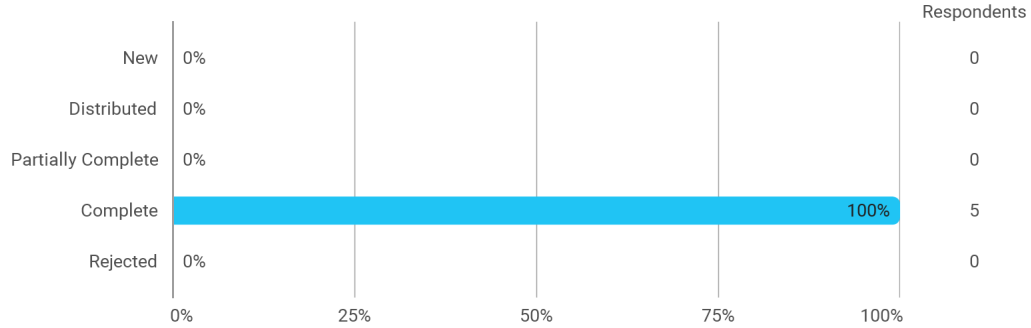
Overall Status

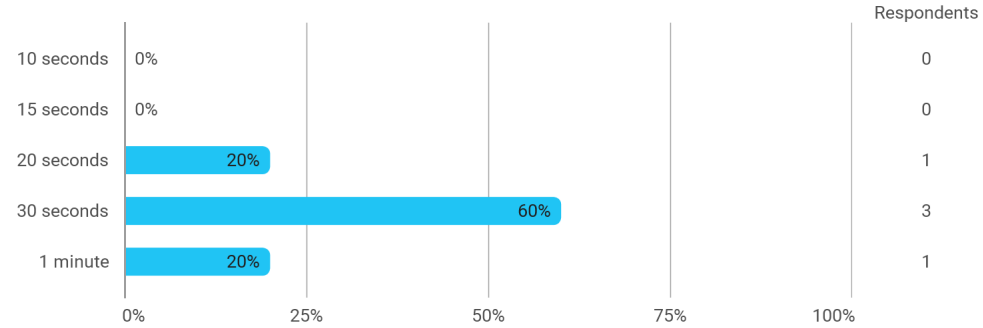


b) Prototype Evaluation 1: Post-Questionnaire

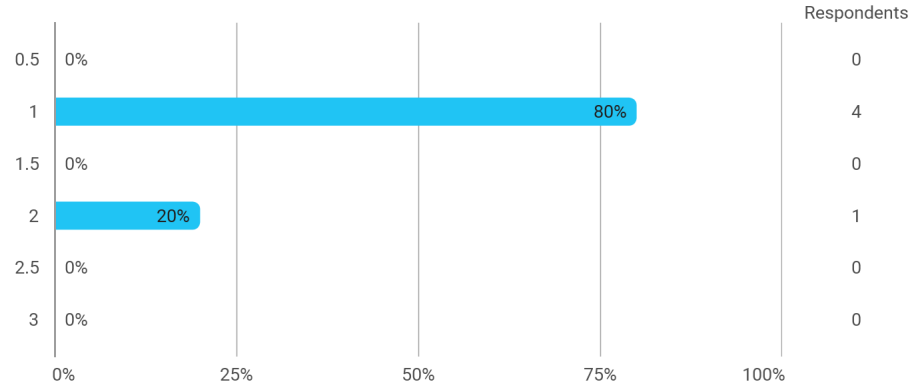
1: How was this way of practicing hygiene precautions compared to other channels with the same information (ex. reading information brochures, watching news).

- More challenging.
- Morsom måte å lære hygiene på, enn å høre det igjennom en skjerm.
- I do not really know
- more fun and praktical
- Very good and informative!

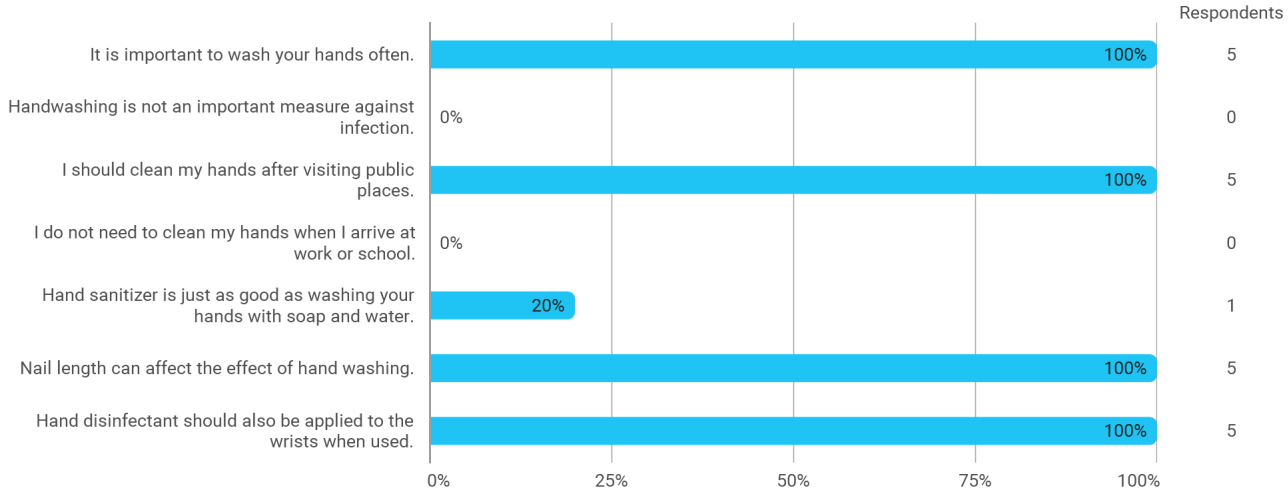
2: How long should you wash your hands?



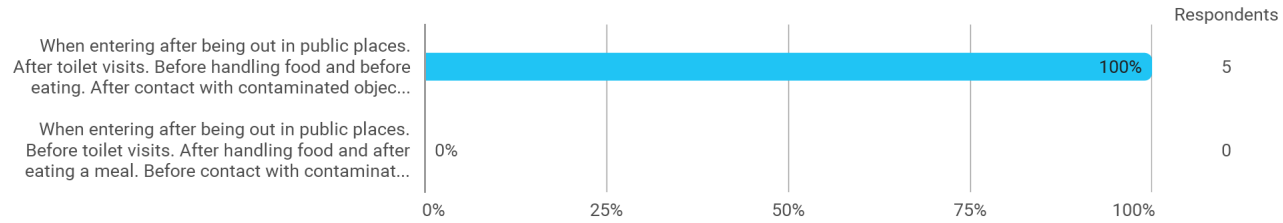
3: Keep _ meter distance to other people.



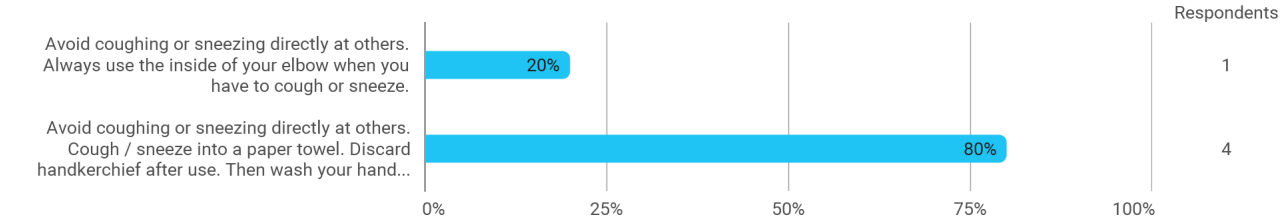
4: Which statements are true? (multiple answers can be correct)



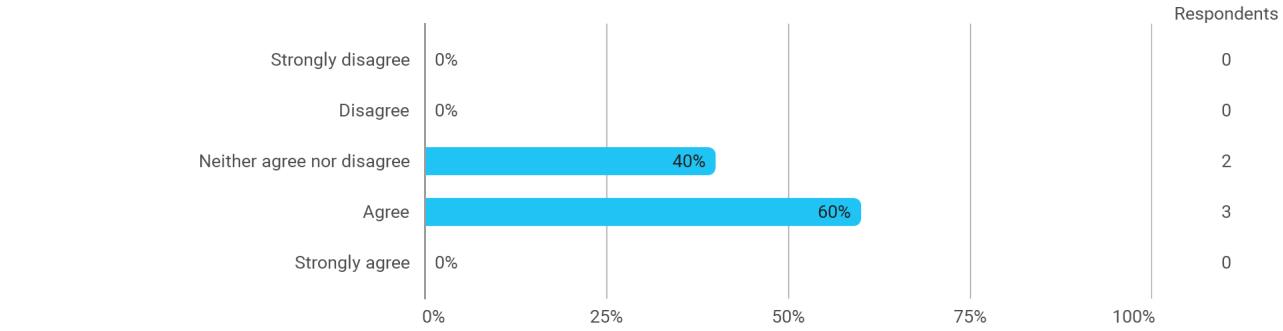
5: When is it recommended to wash your hands in the workplace?



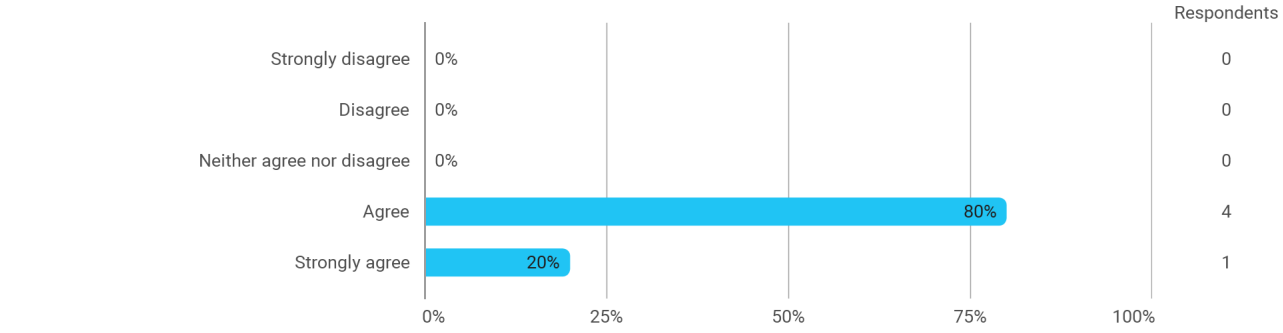
6: What is important to think about when coughing or sneezing?

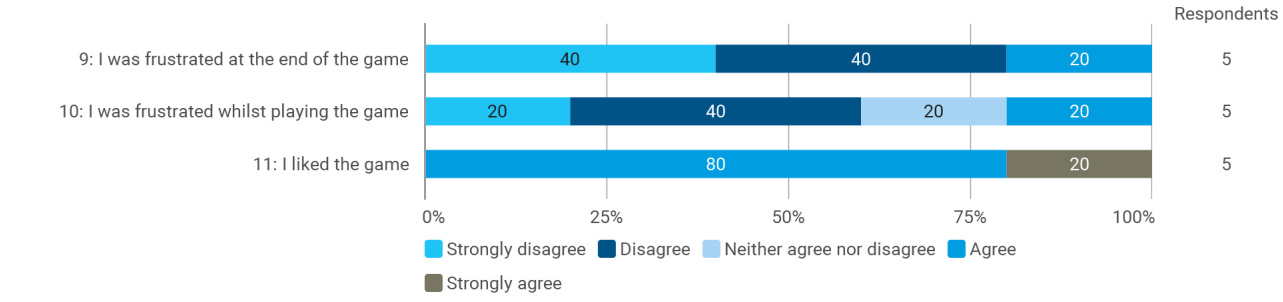


7: My knowledge about hygiene precautions improved after playing

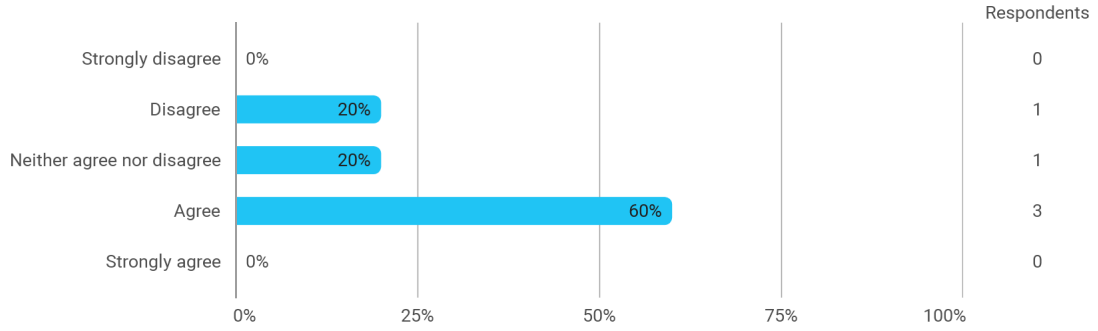


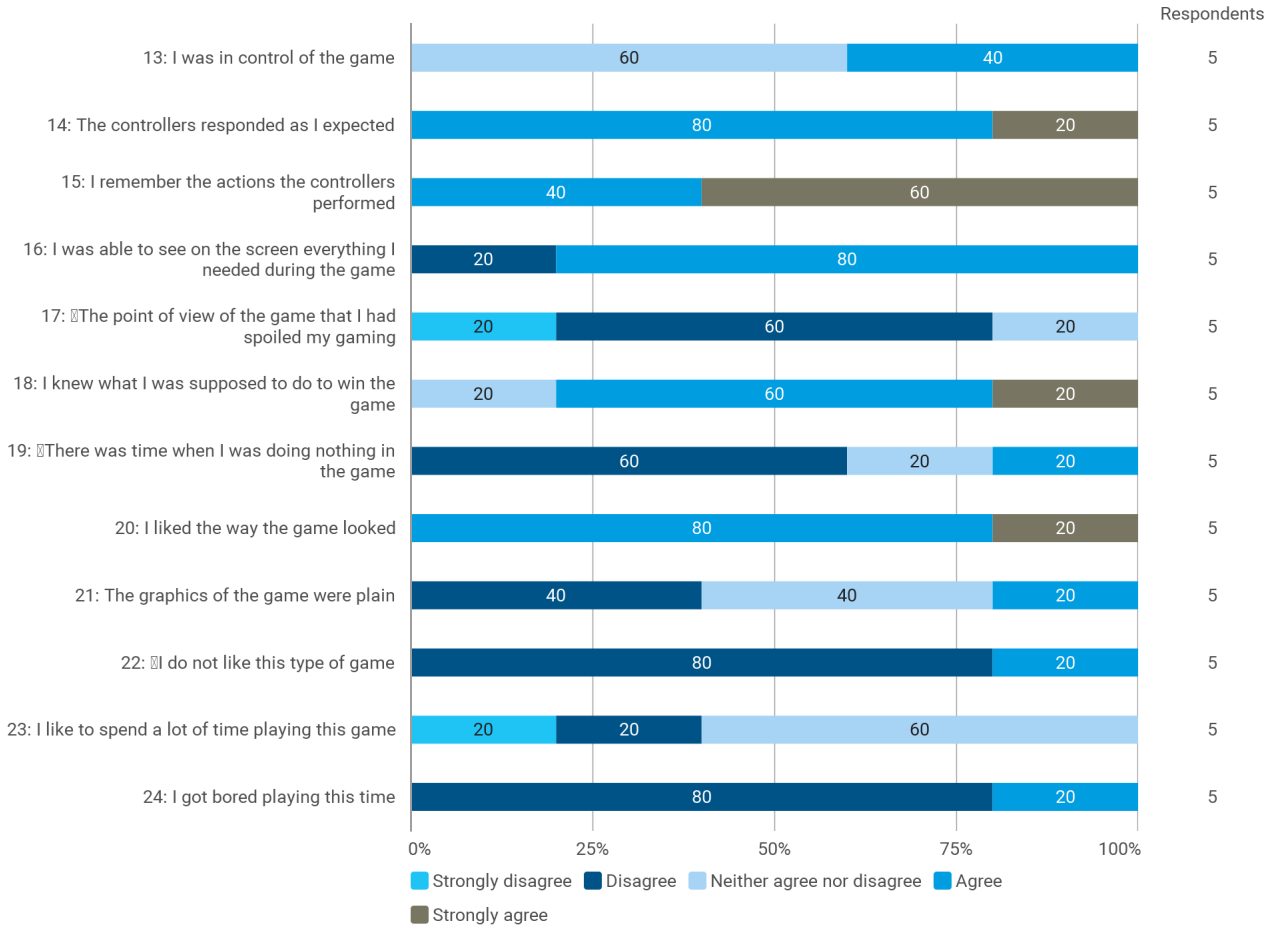
8: I enjoyed playing the game



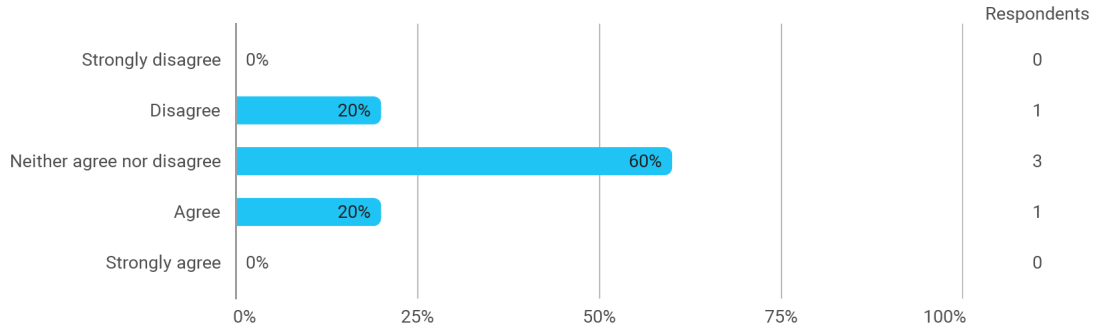


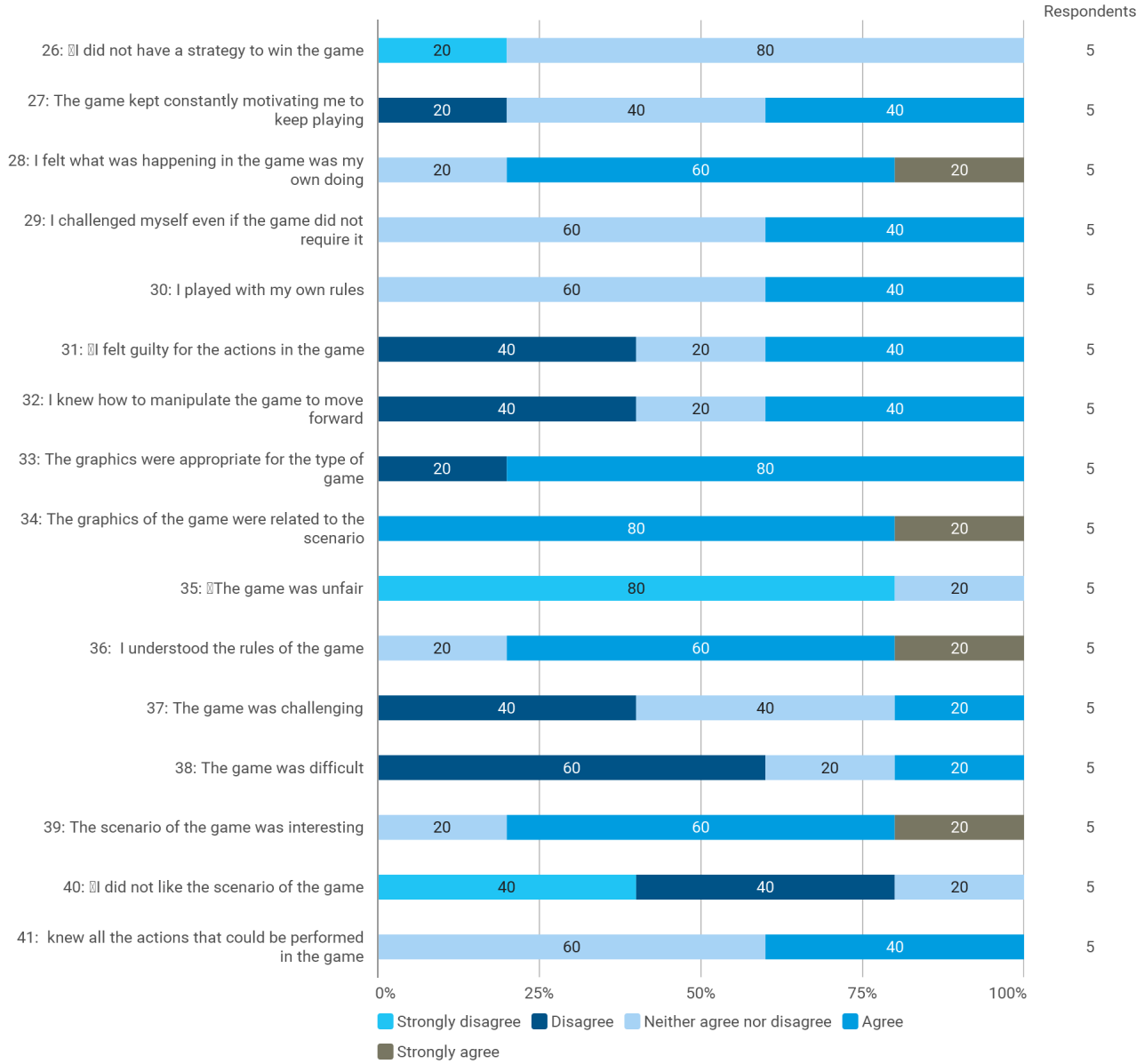
12: I would play this game again





25: ∗I usually do not choose this type of game



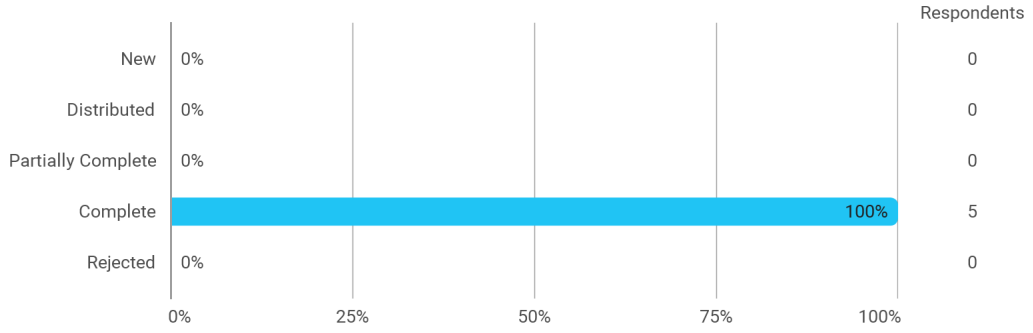


42: Do you have any suggestions that could improve the experience when playing this game?

- Enklere løsning for å finne heisen
- Minimap
- fix "bugs" with the people getting stuck when moving arbound. elevator was hard to find, should be more clear. maybe a mini map to help with navigating. more decor could make it more fun to explore outside of the things to do in the game.

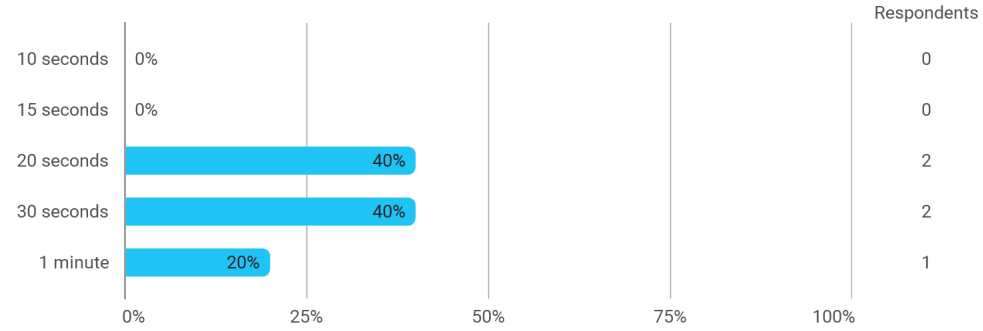
E-mail

Overall Status

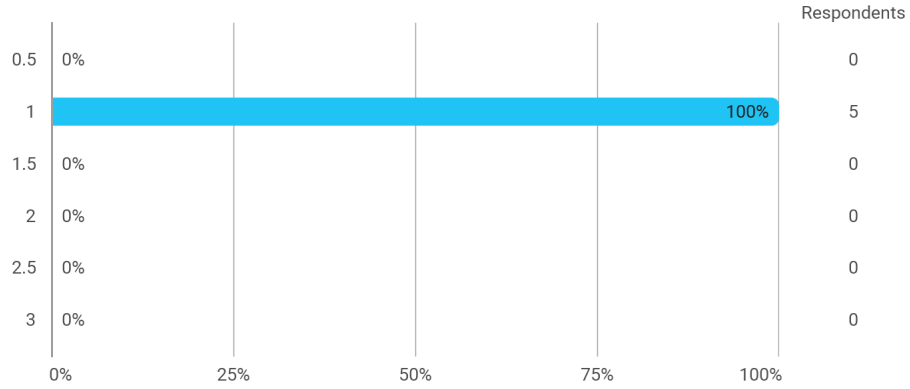


c) Prototype Evaluation 2: Post-Questionnaire

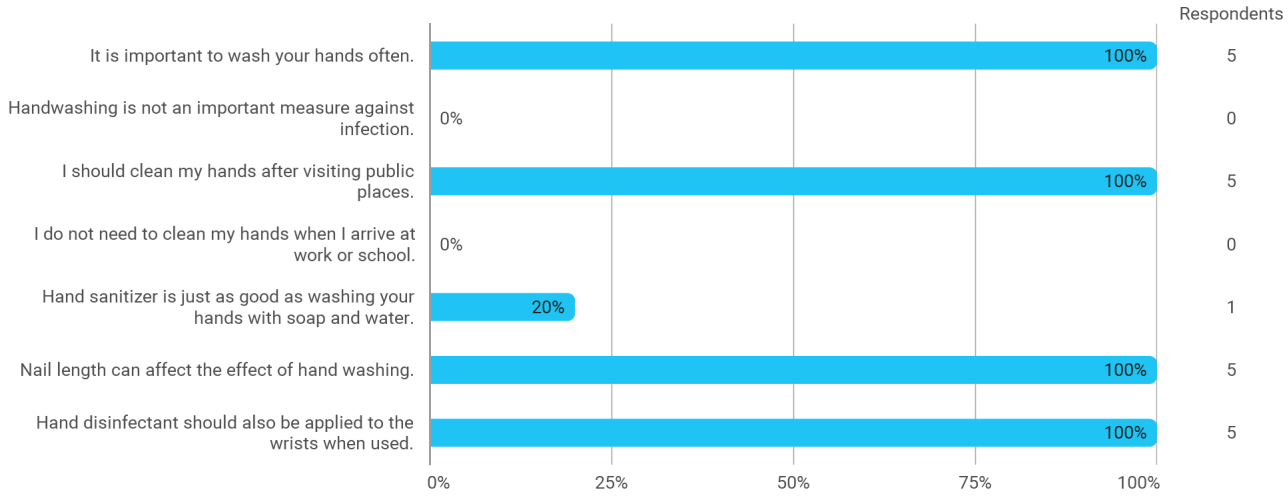
1: How long should you wash your hands?



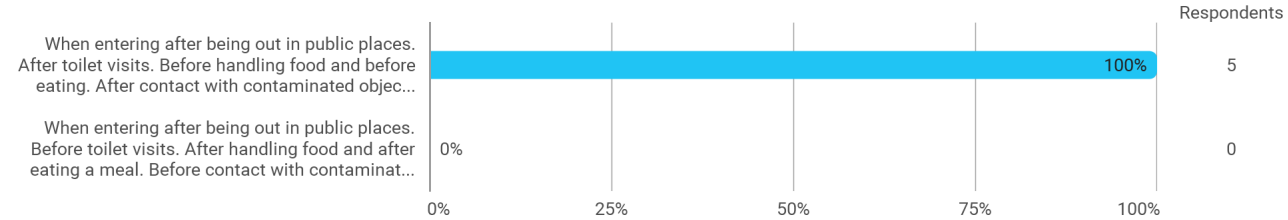
2: Keep _ meter distance to other people.



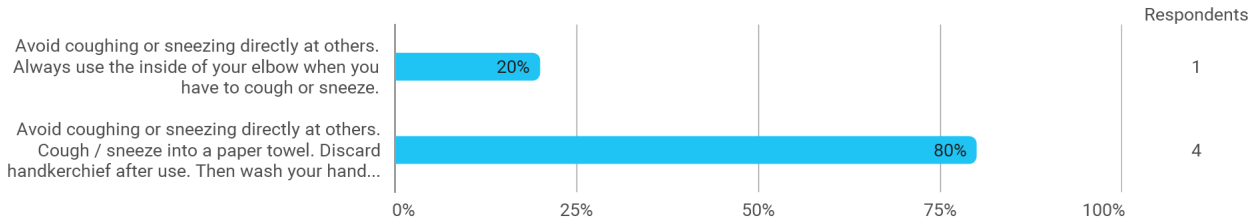
3: Which statements are true? (multiple answers can be correct)



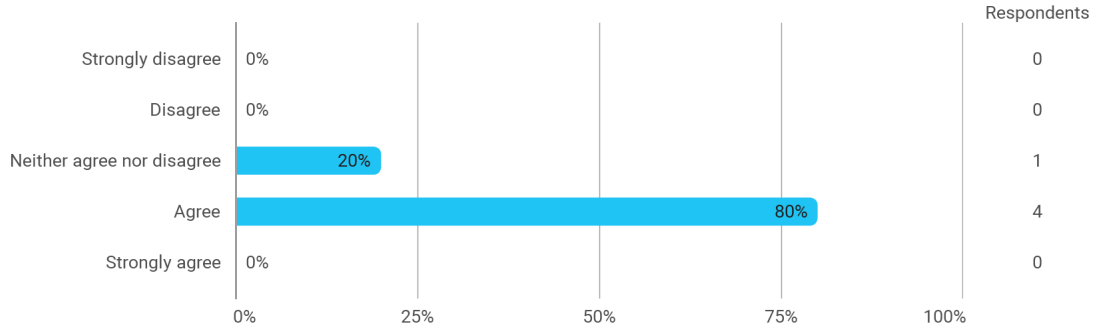
4: When is it recommended to wash your hands in the workplace?



5: What is important to think about when coughing or sneezing?

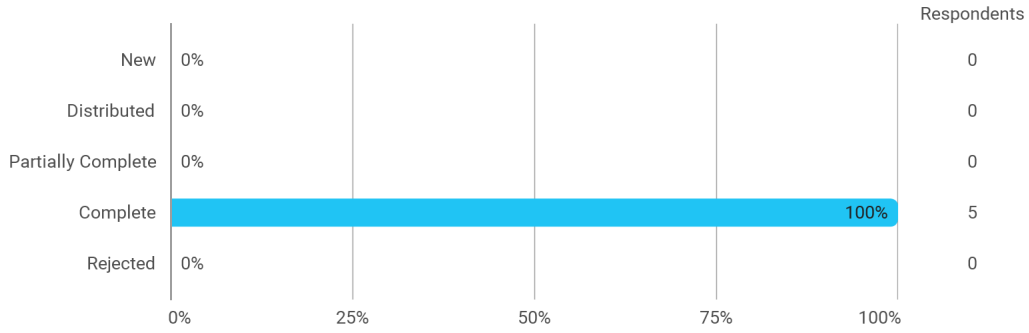


6: My knowledge about hygiene precautions improved after playing



E-mail

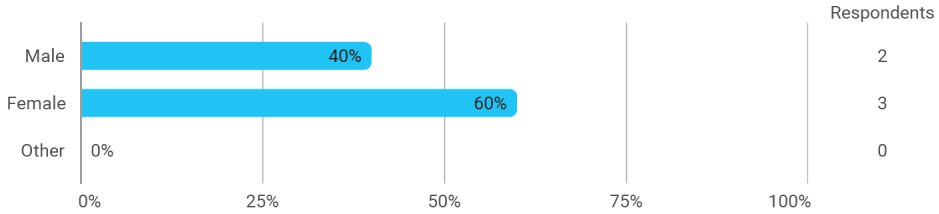
Overall Status



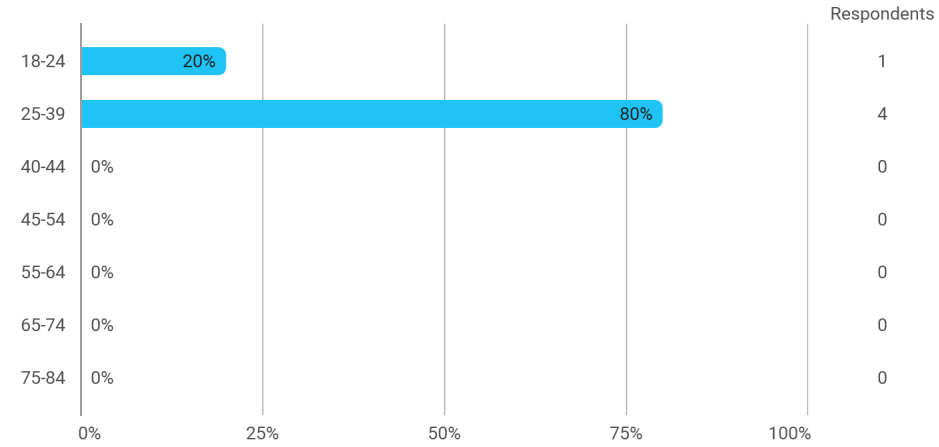
2. Control Group (Course)

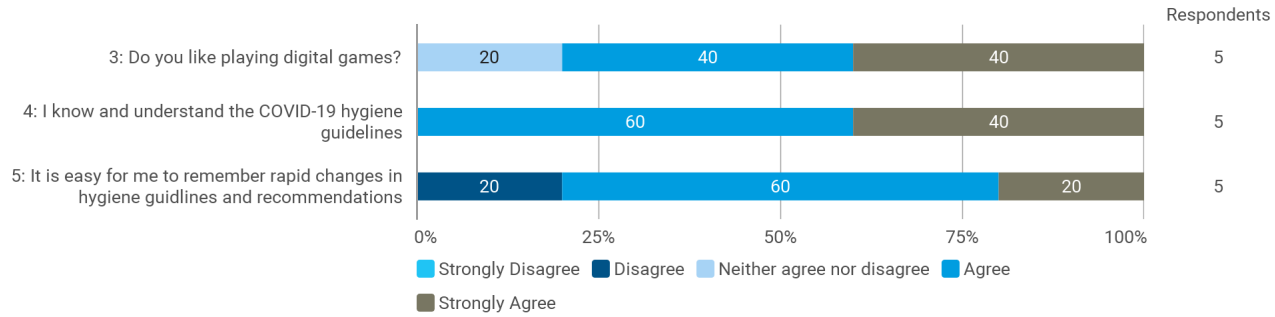
a) Course Evaluation 1: Pre-Questionnaire

1: Gender



2: Age

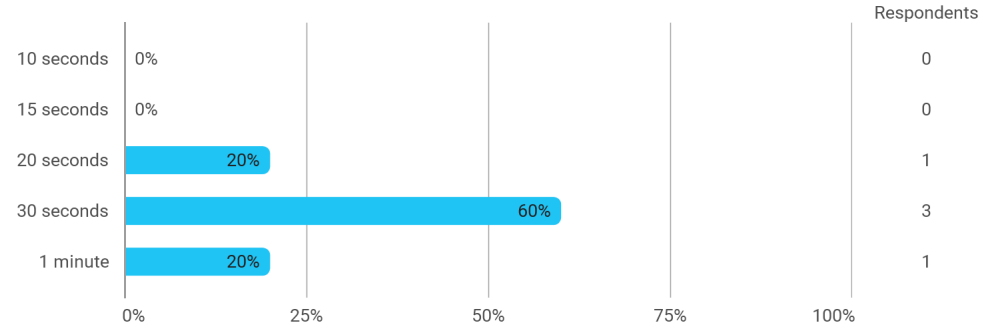




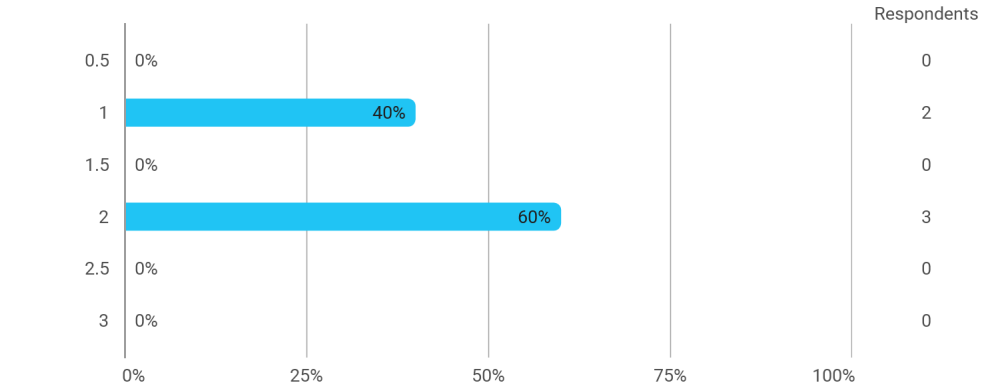
6: How/where have you learned about the COVID-19 hygiene guidelines during this pandemic?

- work and tv
- Fra mennesker, nyhetene
- Hos regjeringen.no, hver enkelt kommune sin nettside over lokale tilltak. Også, VG, TV2, Dagbladet.
- At work.
- Gjennom jobb og oppdateringer fra det offentlige.

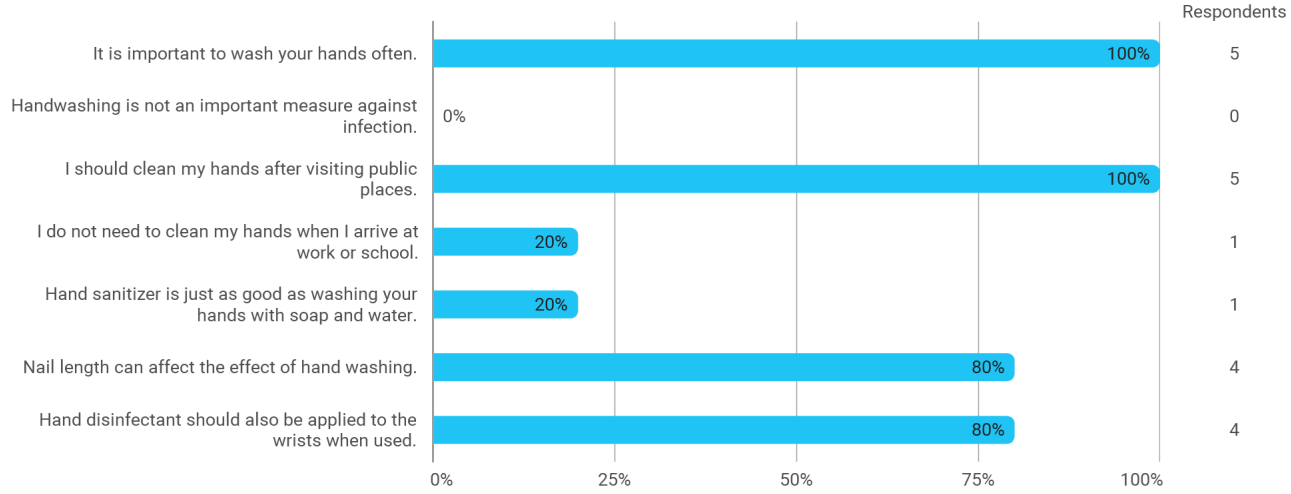
7: How long should you wash your hands?



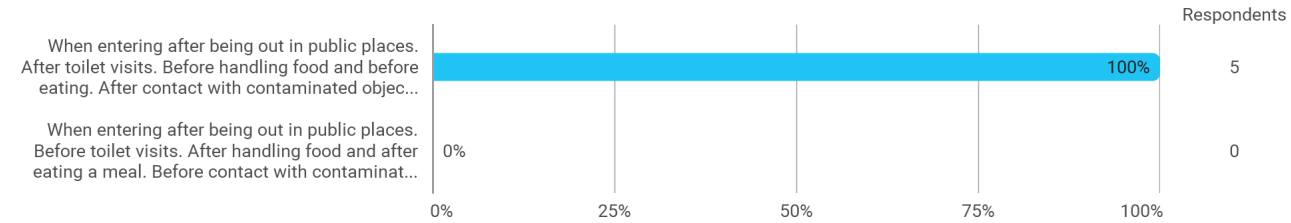
8: Keep _ meter distance to other people.



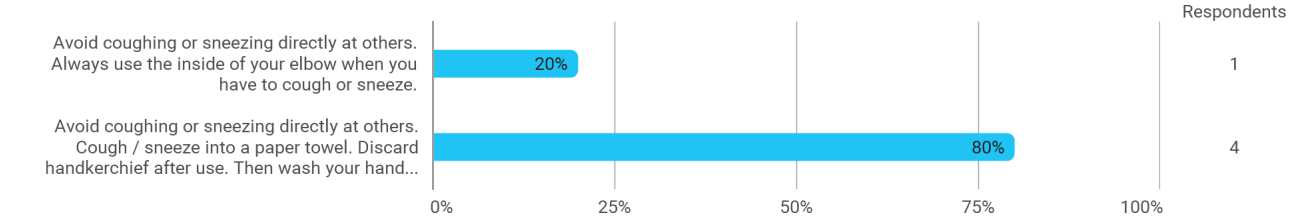
9: Which statements are true? (multiple answers can be correct)



10: When is it recommended to wash your hands in the workplace?

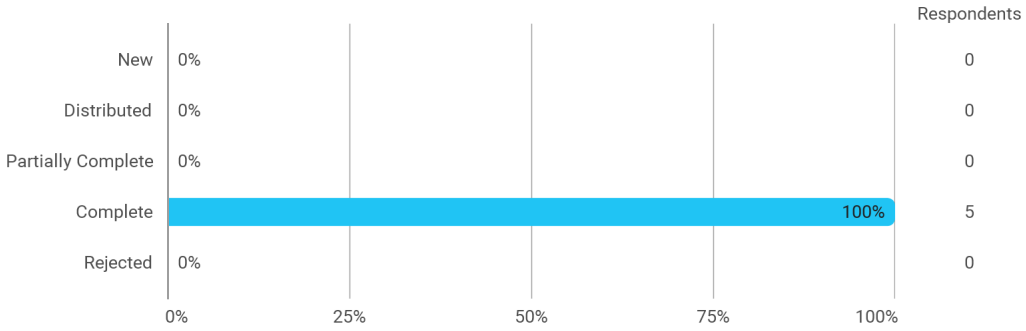


11: What is important to think about when coughing or sneezing?



E-mail

Overall Status

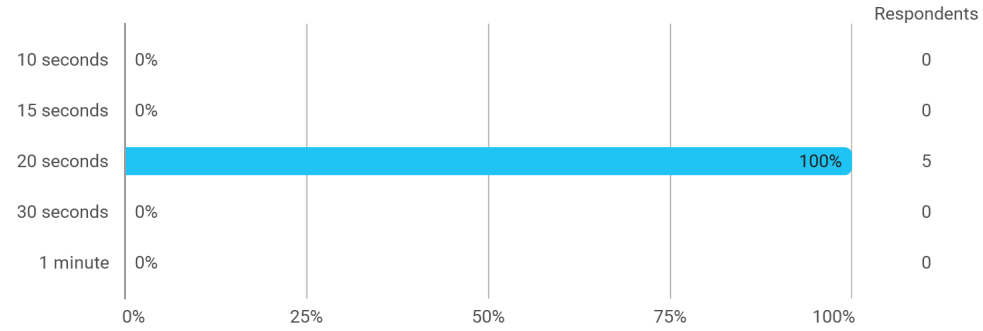


b) Course Evaluation 1: Post-Questionnaire

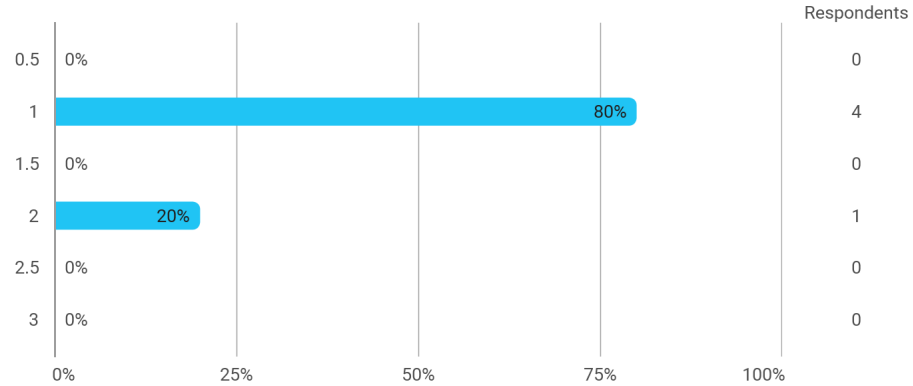
1: How was this way of practicing hygiene precautions compared to other channels with the same information (ex. reading information brochures, watching news).

- somewhat repetetive of everything i hear on tv and so on. but nice to do it at home whenever i got time for it..
- Synes det var mye enkere å få oppgaver. Trodde jeg kunne absolutt alt, men nå burde jeg hvertfall kunne alt.
- Veldig god! Mer spennende, underholdende og du får mulighet til å vise hva du kan.
- Informative - easyer to remeber.
- Enkelt og grei informasjon om typiske regler.

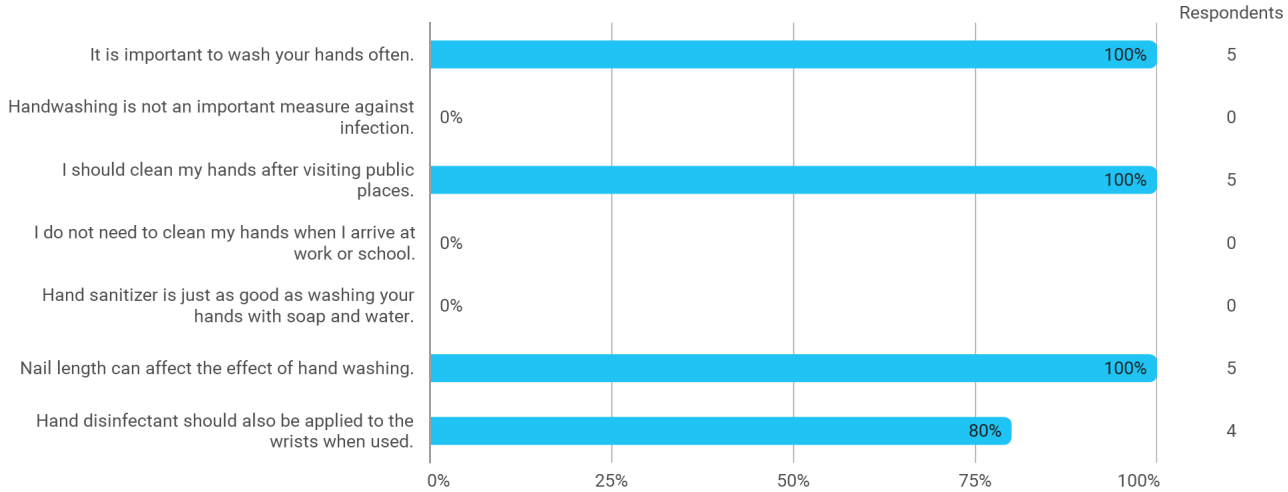
2: How long should you wash your hands?



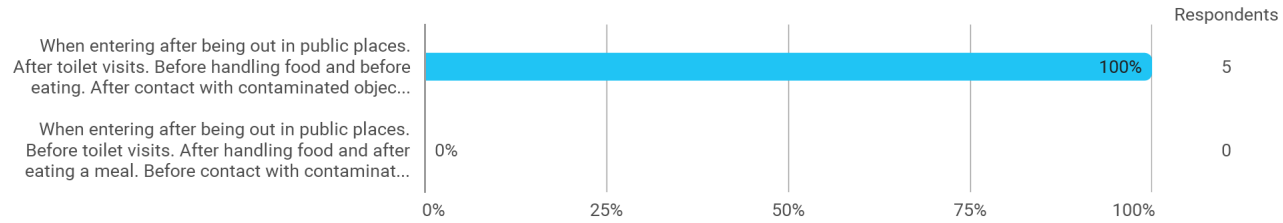
3: Keep _ meter distance to other people.



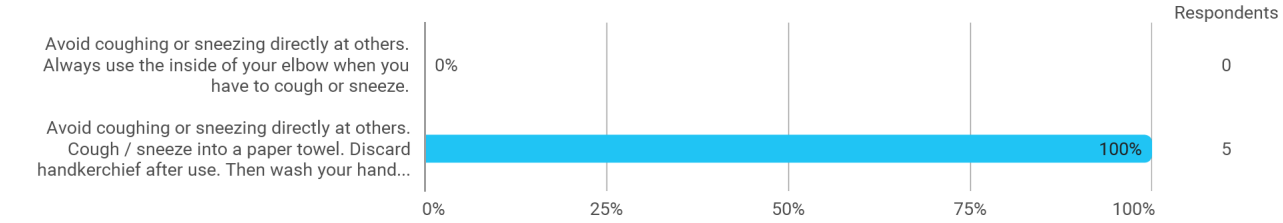
4: Which statements are true? (multiple answers can be correct)

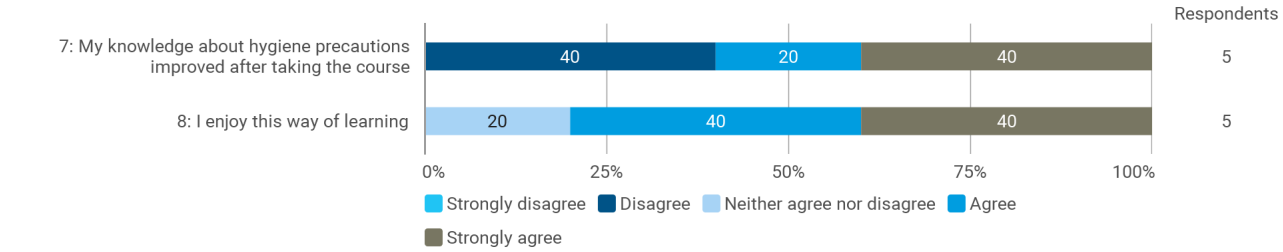


5: When is it recommended to wash your hands in the workplace?



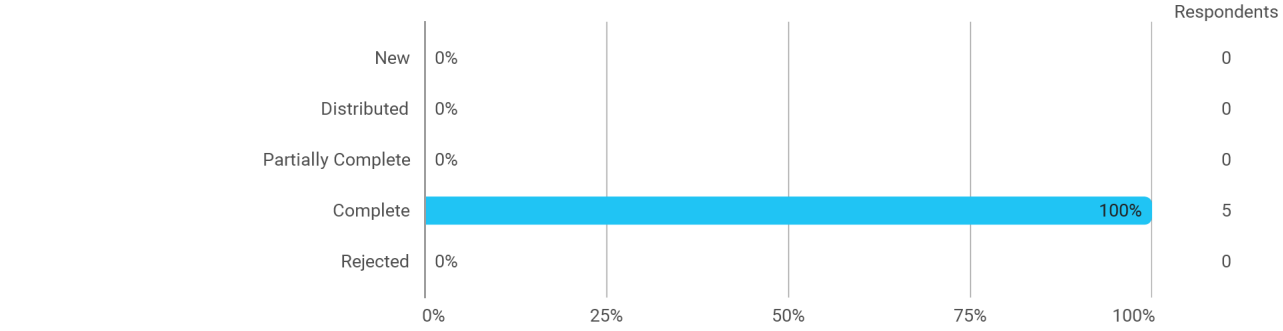
6: What is important to think about when coughing or sneezing?





E-mail

Overall Status



3. Prototype: Game Results

a) First Playthrough

	P1	P2	P3	P4	P5
Total Time	09:31	08:16	06:12	08:07	05:38
Failed at social distancing	2	8	6	26	0
Times washed hands	23	2	2	13	7
Times used hand sanitizer	17	18	9	11	31

Mean	Median	SD	
08:07	07:33	01:36	Total Time
8,4	6,0	10,3	Failed at social distancing
9,4	7,0	8,8	Times washed hands
17,2	14,0	8,6	Times used hand sanitizer

b) Second Playthrough

Test Session 2	P1	P2	P3	P4	P5
Total Time	07:26	05:59	03:26	05:35	04:54
Failed at social distancing	0	7	2	7	0
Times washed hands	1	5	0	4	30
Times used hand sanitizer	1	8	11	6	31

Mean	Median	SD	
05:28	05:35	01:28	Total Time
3,2	2,0	3,6	Failed at social distancing
8	4,0	12,5	Times washed hands
11,4	8,0	11,5	Times used hand sanitizer

B. Questionnaires

1. Pre-Prototype Evaluation Questionnaire (Game)

General information

1: Gender

(1) ❑ Male
(2) ❑ Female
(3) ❑ Other

2: Age

(1) ❑ 18-24
(2) ❑ 25-39
(3) ❑ 40-44
(4) ❑ 45-54
(5) ❑ 55-64
(6) ❑ 65-74
(7) ❑ 75-84

3: Do you like playing digital games?

(1) ❑ Strongly Disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly Agree

4: I know and understand the COVID-19 hygiene guidelines

(1) ❑ Strongly Disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly Agree

5: It is easy for me to remember rapid changes in hygiene guidlines and recommendations

(1) ❑ Strongly Disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly Agree

6: How/where have you learned about the COVID-19 hygiene guidelines during this pandemic?

_____
_____
_____
_____
_____
_____

7: How long should you wash your hands?

(2) ❑ 10 seconds
(3) ❑ 15 seconds
(4) ❑ 20 seconds
(5) ❑ 30 seconds
(1) ❑ 1 minute

8: Keep _ meter distance to other people.

(1) ❑ 0.5
(2) ❑ 1
(3) ❑ 1.5
(4) ❑ 2
(5) ❑ 2.5
(6) ❑ 3

9: Which statements are true? (multiple answers can be correct)

(1) ❑ It is important to wash your hands often.
(2) ❑ Handwashing is not an important measure against infection.

(3) ❑ I should clean my hands after visiting public places.

(4) ❑ I do not need to clean my hands when I arrive at work or school.

(5) ❑ Hand sanitizer is just as good as washing your hands with soap and water.

(6) ❑ Nail length can affect the effect of hand washing.

(7) ❑ Hand disinfectant should also be applied to the wrists when used.

10: When is it recommended to wash your hands in the workplace?

(1) ❑ When entering after being out in public places. After toilet visits. Before handling food and before eating. After contact with contaminated objects and equipment. After gloves are removed. After coughing, sneezing, and after brushing your nose.

(2) ❑ When entering after being out in public places. Before toilet visits. After handling food and after eating a meal. Before contact with contaminated objects and equipment. After gloves are removed. Before coughing, sneezing, and before brushing your nose.

11: What is important to think about when coughing or sneezing?

(1) ❑ Avoid coughing or sneezing directly at others. Always use the inside of your elbow when you have to cough or sneeze.

(2) ❑ Avoid coughing or sneezing directly at others. Cough / sneeze into a paper towel. Discard handkerchief after use. Then wash your hands. Use the inside of the elbow when you have to cough or sneeze and do not have paper available.

2. Post-Prototype Evaluation Questionnaire: First Evaluation (Game)

This questionnaire should be answered after you have played through the prototype.

1: How was this way of practicing hygiene precautions compared to other channels with the same information (ex. reading information brochures, watching news).

_____
_____
_____
_____
_____
_____

2: How long should you wash your hands?

(2) ❑ 10 seconds
(3) ❑ 15 seconds
(4) ❑ 20 seconds
(5) ❑ 30 seconds
(1) ❑ 1 minute

3: Keep _ meter distance to other people.

(1) ❑ 0.5
(2) ❑ 1
(3) ❑ 1.5
(4) ❑ 2
(5) ❑ 2.5
(6) ❑ 3

4: Which statements are true? (multiple answers can be correct)

(1) ❑ It is important to wash your hands often.
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(3) ❑ I should clean my hands after visiting public places.
(4) ❑ I do not need to clean my hands when I arrive at work or school.
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(2) ❑ When entering after being out in public places. Before toilet visits. After handling food and after eating a meal. Before contact with contaminated objects and equipment. After gloves are removed. Before coughing, sneezing, and before brushing your nose.

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(2) ❑ Avoid coughing or sneezing directly at others. Cough / sneeze into a paper towel. Discard handkerchief after use. Then wash your hands. Use the inside of the elbow when you have to cough or sneeze and do not have paper available.

7: My knowledge about hygiene precautions improved after playing

(1) ❑ Strongly disagree

(2) ❑ Disagree

(3) ❑ Neither agree nor disagree

(5) ❑ Agree

(6) ❑ Strongly agree

8: I enjoyed playing the game

(1) ❑ Strongly disagree

(2) ❑ Disagree

(4) ❑ Neither agree nor disagree

(5) ❑ Agree

(6) ❑ Strongly agree

9: I was frustrated at the end of the game

(1) ❑ Strongly disagree

(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly agree

10: I was frustrated whilst playing the game

(1) ❑ Strongly disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly agree

11: I liked the game

(1) ❑ Strongly disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly agree

12: I would play this game again

(1) ❑ Strongly disagree
(2) ❑ Disagree
(4) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly agree

13: I was in control of the game

(1) ❑ Strongly disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly agree

14: The controllers responded as I expected

(1) ❑ Strongly disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly agree

15: I remember the actions the controllers performed

(1) ❑ Strongly disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly agree

16: I was able to see on the screen everything I needed during the game

(1) ❑ Strongly disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly agree

17: ∗The point of view of the game that I had spoiled my gaming

(1) ❑ Strongly disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly agree

18: I knew what I was supposed to do to win the game

(1) ❑ Strongly disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly agree

19: ∗There was time when I was doing nothing in the game

(1) ❑ Strongly disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly agree

20: I liked the way the game looked

(1) ❑ Strongly disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly agree

21: The graphics of the game were plain

(1) ❑ Strongly disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly agree

22: ∗I do not like this type of game

(1) ❑ Strongly disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly agree

23: I like to spend a lot of time playing this game

(1) ❑ Strongly disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree

(5) ❑ Agree

(6) ❑ Strongly agree

24: I got bored playing this time

(1) ❑ Strongly disagree

(2) ❑ Disagree

(3) ❑ Neither agree nor disagree

(5) ❑ Agree

(6) ❑ Strongly agree

25: ∗I usually do not choose this type of game

(1) ❑ Strongly disagree

(2) ❑ Disagree

(4) ❑ Neither agree nor disagree

(5) ❑ Agree

(6) ❑ Strongly agree

26: ∗I did not have a strategy to win the game

(1) ❑ Strongly disagree

(2) ❑ Disagree

(3) ❑ Neither agree nor disagree

(5) ❑ Agree

(6) ❑ Strongly agree

27: The game kept constantly motivating me to keep playing

(1) ❑ Strongly disagree

(2) ❑ Disagree

(3) ❑ Neither agree nor disagree

(5) ❑ Agree

(6) ❑ Strongly agree

28: I felt what was happening in the game was my own doing

(1) ❑ Strongly disagree

(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly agree

29: I challenged myself even if the game did not require it

(1) ❑ Strongly disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly agree

30: I played with my own rules

(1) ❑ Strongly disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly agree

31: ∗I felt guilty for the actions in the game

(1) ❑ Strongly disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly agree

32: I knew how to manipulate the game to move forward

(1) ❑ Strongly disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly agree

33: The graphics were appropriate for the type of game

(1) ❑ Strongly disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly agree

34: The graphics of the game were related to the scenario

(1) ❑ Strongly disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly agree

35: ∗The game was unfair

(1) ❑ Strongly disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly agree

36: I understood the rules of the game

(1) ❑ Strongly disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly agree

37: The game was challenging

(1) ❑ Strongly disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly agree

38: The game was difficult

(1) ❑ Strongly disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly agree

39: The scenario of the game was interesting

(1) ❑ Strongly disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly agree

40: ∗I did not like the scenario of the game

(1) ❑ Strongly disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly agree

41: knew all the actions that could be performed in the game

(1) ❑ Strongly disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly agree

42: Do you have any suggestions that could improve the experience when playing this game?

_____
_____
_____

_____
_____
_____

Thank you for participating in this evaluation!

3. Post-Prototype Evaluation Questionnaire: Second Evaluation (Game)

This questionnaire should be answered after you have played through the prototype for a second time. Thank you for sharing your time.

1: How long should you wash your hands?

(2) ❑ 10 seconds
(3) ❑ 15 seconds
(4) ❑ 20 seconds
(5) ❑ 30 seconds
(1) ❑ 1 minute

2: Keep _ meter distance to other people.

(1) ❑ 0.5
(2) ❑ 1
(3) ❑ 1.5
(4) ❑ 2
(5) ❑ 2.5
(6) ❑ 3

3: Which statements are true? (multiple answers can be correct)

(1) ❑ It is important to wash your hands often.
(2) ❑ Handwashing is not an important measure against infection.
(3) ❑ I should clean my hands after visiting public places.
(4) ❑ I do not need to clean my hands when I arrive at work or school.
(5) ❑ Hand sanitizer is just as good as washing your hands with soap and water.
(6) ❑ Nail length can affect the effect of hand washing.
(7) ❑ Hand disinfectant should also be applied to the wrists when used.

4: When is it recommended to wash your hands in the workplace?

(1) ❑ When entering after being out in public places. After toilet visits. Before handling food and before eating. After contact with contaminated objects and equipment. After gloves are removed. After coughing, sneezing, and after brushing your nose.

(2) ❑ When entering after being out in public places. Before toilet visits. After handling food and after eating a meal. Before contact with contaminated objects and equipment. After gloves are removed. Before coughing, sneezing, and before brushing your nose.

5: What is important to think about when coughing or sneezing?

(1) ❑ Avoid coughing or sneezing directly at others. Always use the inside of your elbow when you have to cough or sneeze.

(2) ❑ Avoid coughing or sneezing directly at others. Cough / sneeze into a paper towel. Discard handkerchief after use. Then wash your hands. Use the inside of the elbow when you have to cough or sneeze and do not have paper available.

6: My knowledge about hygiene precautions improved after playing

(1) ❑ Strongly disagree

(2) ❑ Disagree

(3) ❑ Neither agree nor disagree

(5) ❑ Agree

(6) ❑ Strongly agree

Thank you for participating in this evaluation!

4. Pre-Course Evaluation Questionnaire (Course)

General information

1: Gender

(1) ❑ Male
(2) ❑ Female
(3) ❑ Other

2: Age

(1) ❑ 18-24
(2) ❑ 25-39
(3) ❑ 40-44
(4) ❑ 45-54
(5) ❑ 55-64
(6) ❑ 65-74
(7) ❑ 75-84

3: Do you like playing digital games?

(1) ❑ Strongly Disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly Agree

4: I know and understand the COVID-19 hygiene guidelines

(1) ❑ Strongly Disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly Agree

5: It is easy for me to remember rapid changes in hygiene guidlines and recommendations

(1) ❑ Strongly Disagree
(2) ❑ Disagree
(3) ❑ Neither agree nor disagree
(5) ❑ Agree
(6) ❑ Strongly Agree

6: How/where have you learned about the COVID-19 hygiene guidelines during this pandemic?

_____
_____
_____
_____
_____
_____

7: How long should you wash your hands?

(2) ❑ 10 seconds
(3) ❑ 15 seconds
(4) ❑ 20 seconds
(5) ❑ 30 seconds
(1) ❑ 1 minute

8: Keep _ meter distance to other people.

(1) ❑ 0.5
(2) ❑ 1
(3) ❑ 1.5
(4) ❑ 2
(5) ❑ 2.5
(6) ❑ 3

9: Which statements are true? (multiple answers can be correct)

(1) ❑ It is important to wash your hands often.
(2) ❑ Handwashing is not an important measure against infection.
(3) ❑ I should clean my hands after visiting public places.
(4) ❑ I do not need to clean my hands when I arrive at work or school.

(5) ❑ Hand sanitizer is just as good as washing your hands with soap and water.

(6) ❑ Nail length can affect the effect of hand washing.

(7) ❑ Hand disinfectant should also be applied to the wrists when used.

10: When is it recommended to wash your hands in the workplace?

(1) ❑ When entering after being out in public places. After toilet visits. Before handling food and before eating. After contact with contaminated objects and equipment. After gloves are removed. After coughing, sneezing, and after brushing your nose.

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(2) ❑ Avoid coughing or sneezing directly at others. Cough / sneeze into a paper towel. Discard handkerchief after use. Then wash your hands. Use the inside of the elbow when you have to cough or sneeze and do not have paper available.

5. Post-Course Evaluation Questionnaire (Course)

This questionnaire should be answered after you have taken the requested part of the course.

1: How was this way of practicing hygiene precautions compared to other channels with the same information (ex. reading information brochures, watching news).

_____
_____
_____
_____
_____
_____

2: How long should you wash your hands?

(2) ❑ 10 seconds
(3) ❑ 15 seconds
(4) ❑ 20 seconds
(5) ❑ 30 seconds
(1) ❑ 1 minute

3: Keep _ meter distance to other people.

(1) ❑ 0.5
(2) ❑ 1
(3) ❑ 1.5
(4) ❑ 2
(5) ❑ 2.5
(6) ❑ 3

4: Which statements are true? (multiple answers can be correct)

(1) ❑ It is important to wash your hands often.
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(2) ❑ Avoid coughing or sneezing directly at others. Cough / sneeze into a paper towel. Discard handkerchief after use. Then wash your hands. Use the inside of the elbow when you have to cough or sneeze and do not have paper available.

7: My knowledge about hygiene precautions improved after taking the course

(1) ❑ Strongly disagree

(2) ❑ Disagree

(3) ❑ Neither agree nor disagree

(5) ❑ Agree

(6) ❑ Strongly agree

8: I enjoy this way of learning

(1) ❑ Strongly disagree

(2) ❑ Disagree

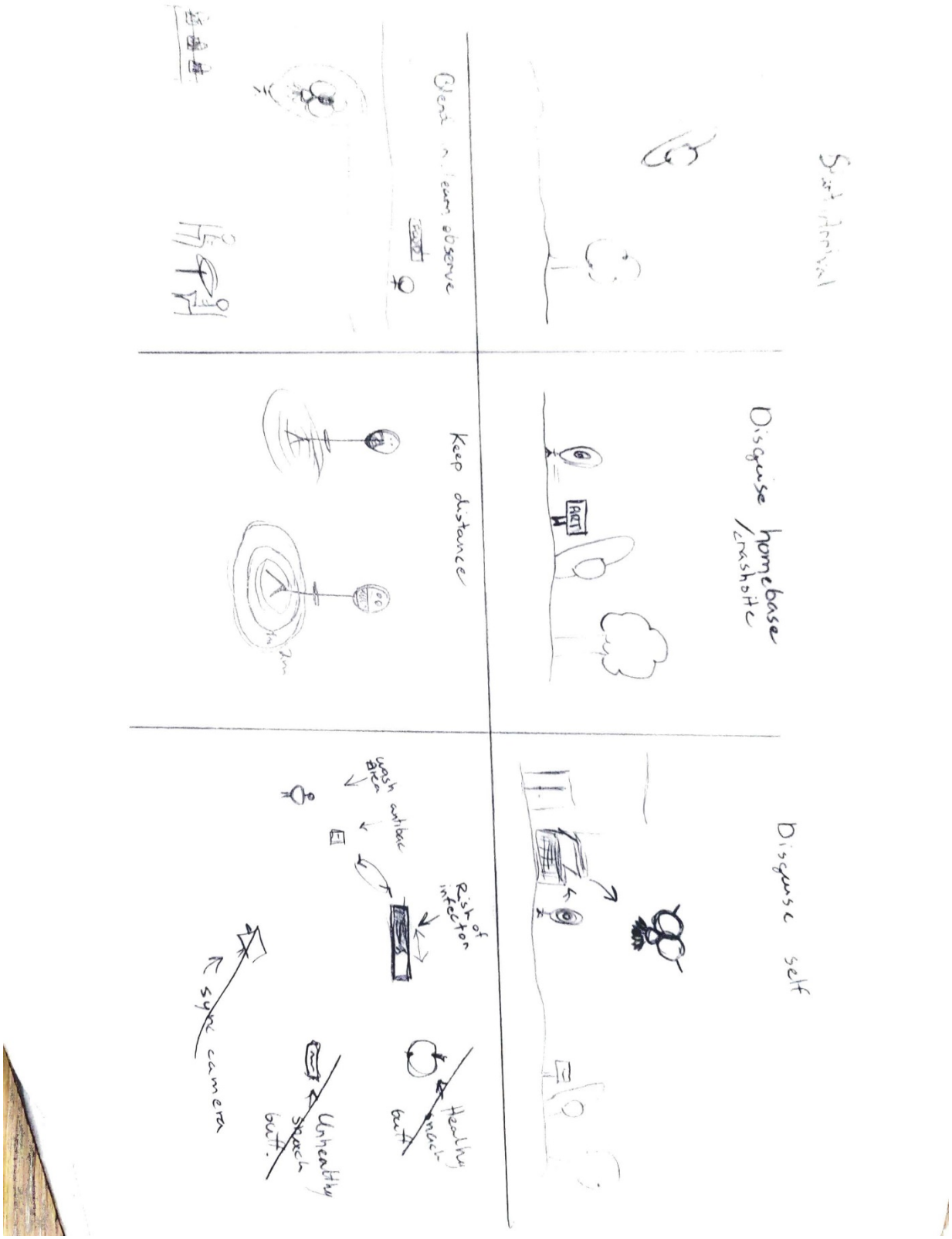
(3) ❑ Neither agree nor disagree

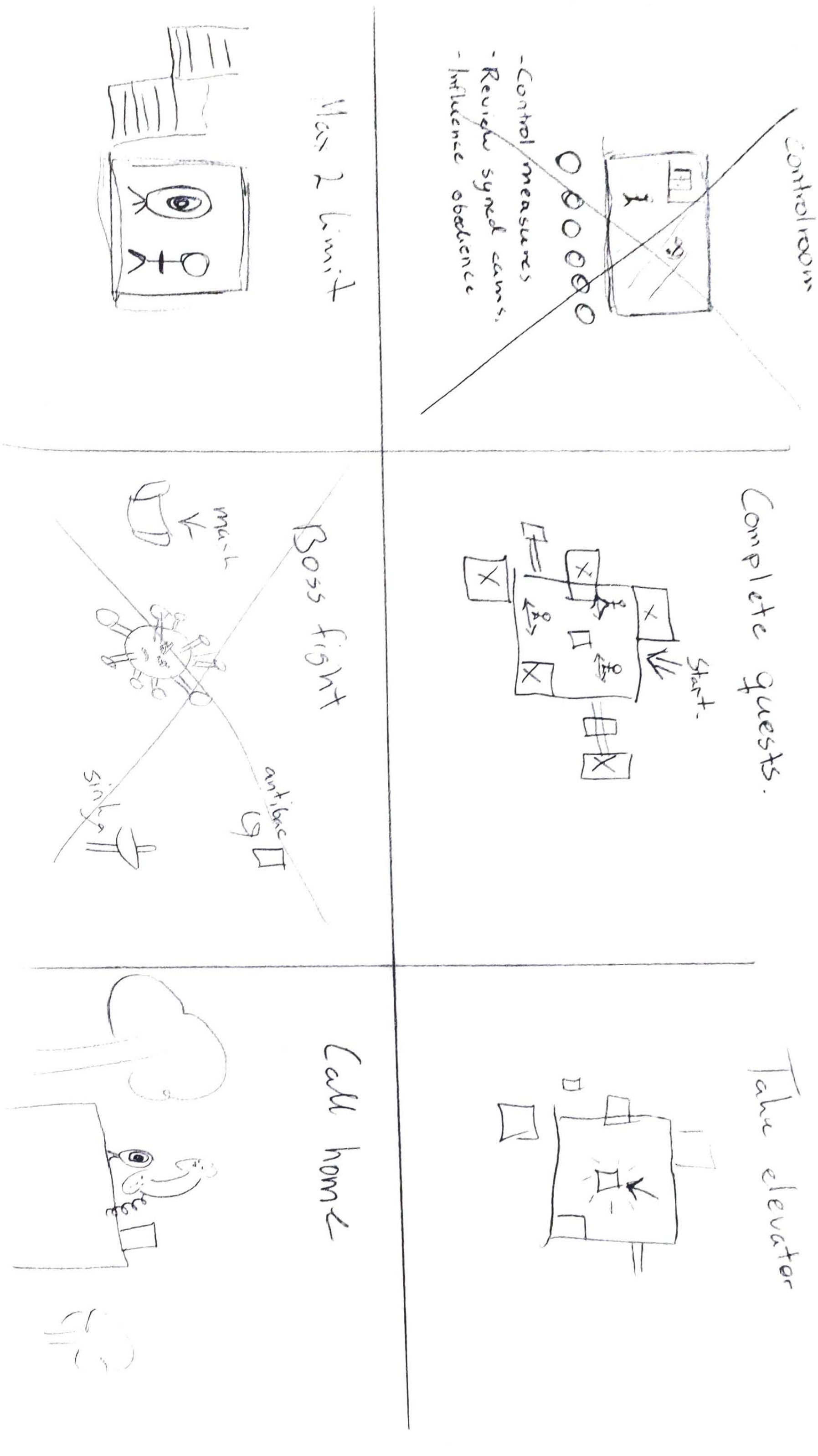
(5) ❑ Agree

(6) ❑ Strongly agree

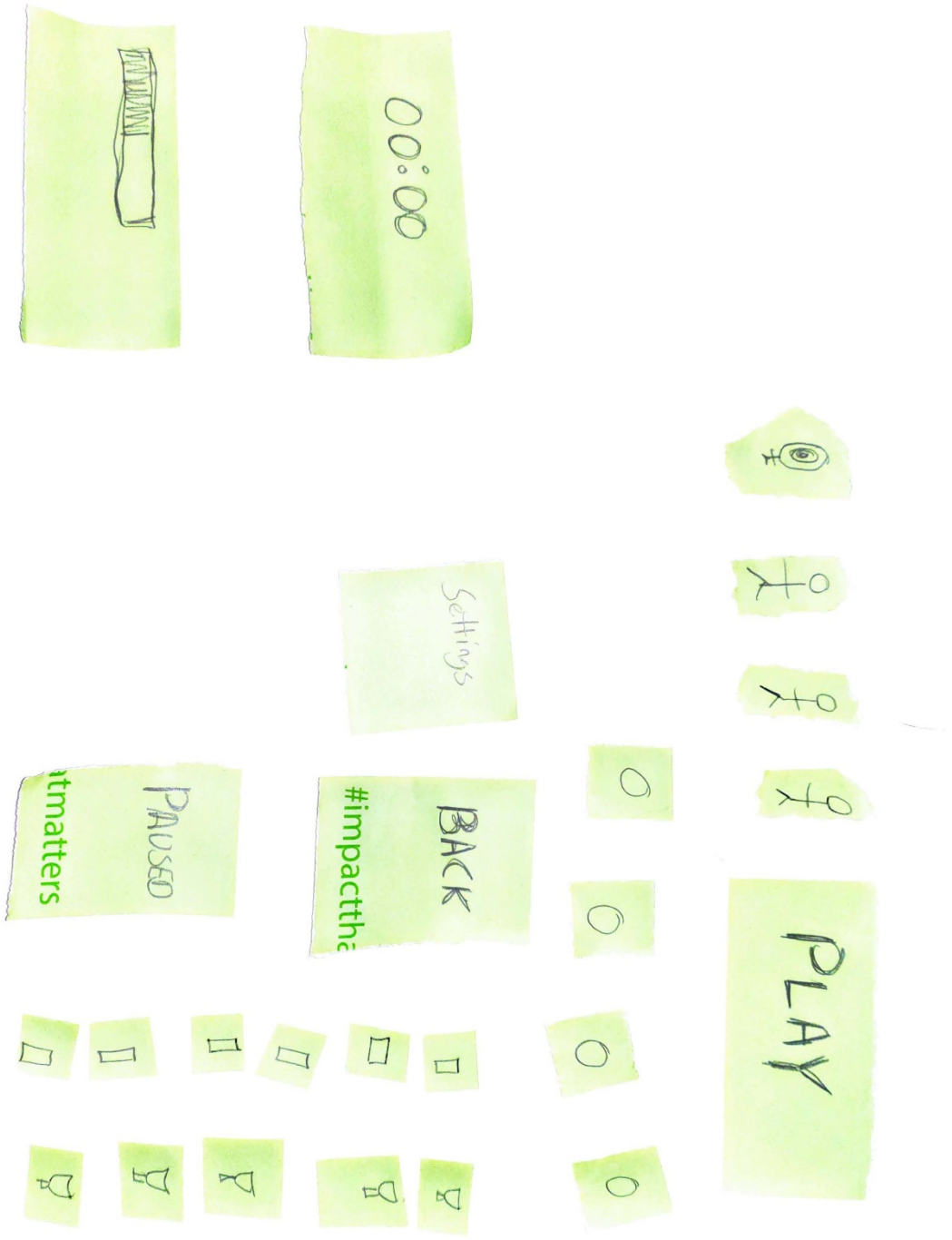
Thank you for participating in this evaluation!

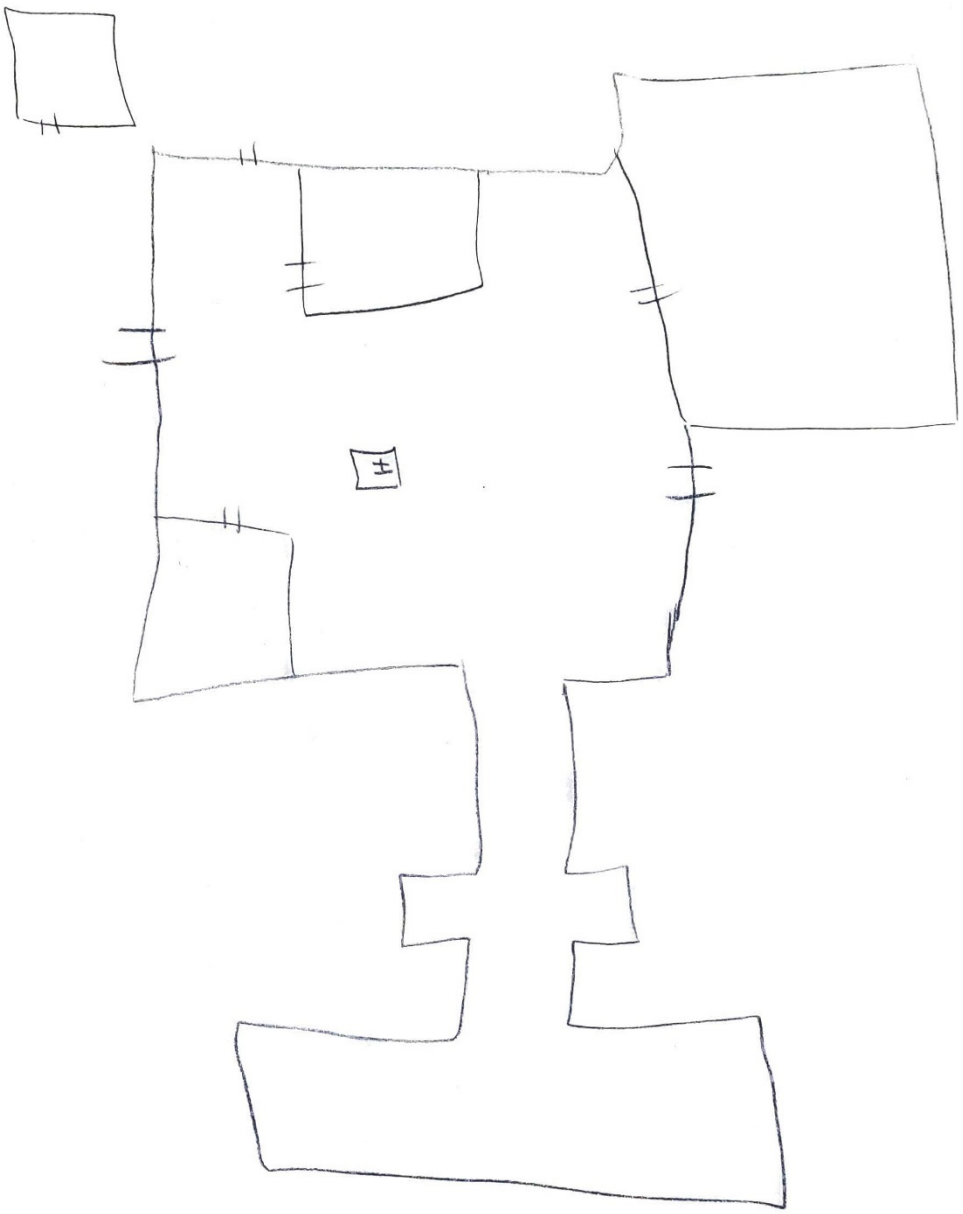
C. Storyboard

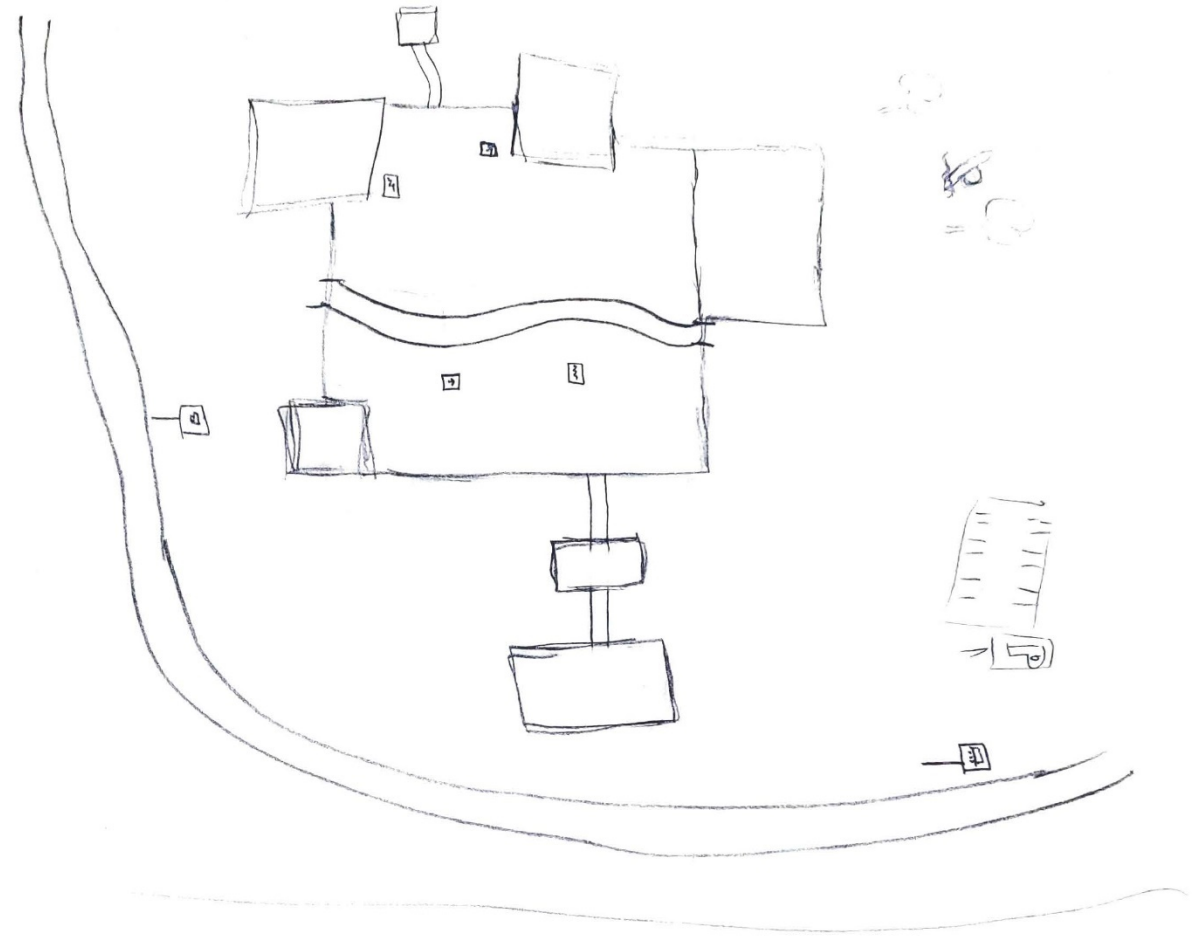


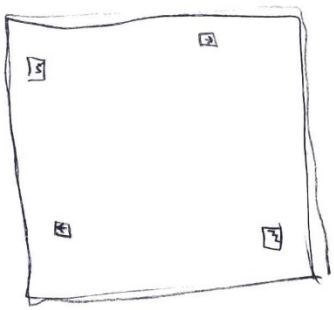

Controlroom
-Control measures
-Review synced cams
-Influence obedience
Max 2 limit
Complete quests.
Start
Boss fight
mask
antibac
Take elevator
Call home

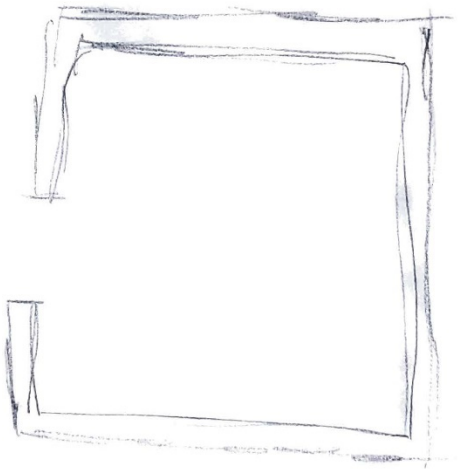
D. Paper Prototype: Parts

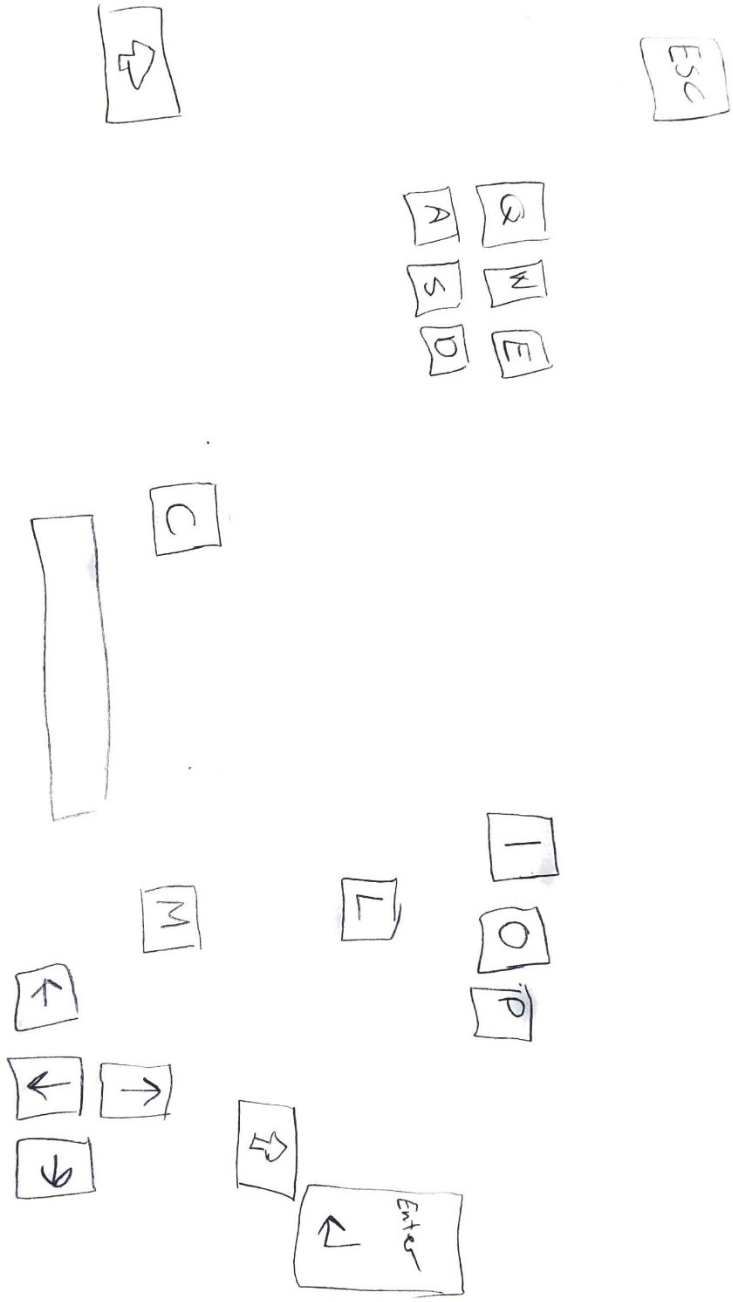








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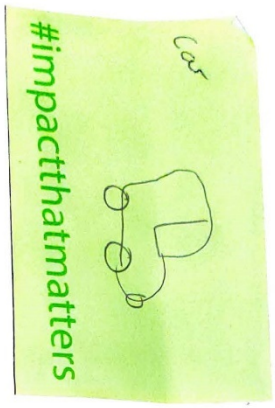
#impactthatmatters


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