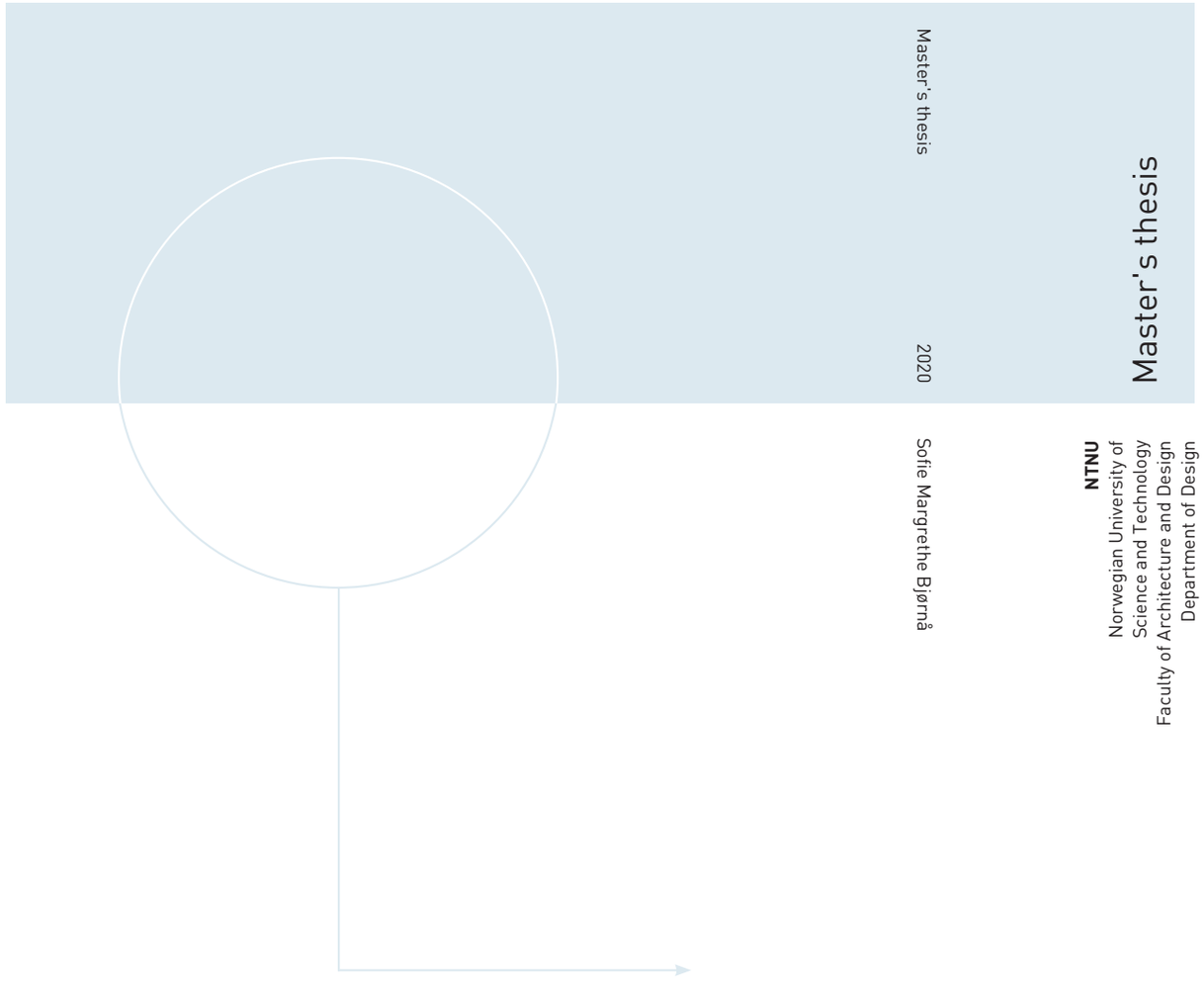

Master's thesis

2020

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Holistic design approach to playful installation experiences

June 2020

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Holistic design approach to playful installation experiences

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Industrial Design Engineering
Submission date: June 2020
Supervisor: Ole Andreas Alsos
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Acknowledgments

Writing this thesis has, for the most part, been a pleasure. There have been moments of frustration and confusion, but I am sure that these memories will fade quickly. With this thesis, I proudly finish my studies after five wonderful years in Trondheim.

I first and foremost want to thank my fantastic supervisor, Ole Andreas Alsos, for motivating me, pushing me and cheering me on through this process. I am grateful for the guidance and valuable discussions we have had the past months.

Parts of this project were conducted as a team. Therefore, I would like to thank Ingrid Medalen (Department of Computer Science) for a lovely collaboration and support throughout the project. I also want to thank Hugo Klævold (Department of Computer Science) for his admirable programming skills, and Henrik Heitmann (Department of Design), who was a great teammate during the development of the installation. I also want to thank the many students who gave their time to participate in the study.

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I would not have been able to complete my studies and this thesis without the support of my family and friends. Thank you, mamma and pappa, Ida, Anton and Oscar, Ingrid, Malin and Kristin.

Thank you, my dearest Jakob.

Sofie Margrethe Bjørnå
Trondheim, juni 2020

Preface

This thesis concludes my Master of Science degree in Industrial Design Engineering at the Department of Design, NTNU. Through my past five years as a design student, I have developed an interest for many different design fields, so choosing a topic for my thesis was challenging. When the opportunity to work with Digiplay arose, it instantly excited me. There were a range of opportunities within the project, which would encourage me to develop my abilities in design and prototyping. Additionally, the project would broaden my understanding of digital technology and programming, and also challenge my user testing and research skills.

Besides my motivation manifested in skill development, I have two main reasons for my interest in this project. Firstly, I truly enjoy creating pleasurable experiences for others, so being able to provide my peers with a fun and engaging activity on campus, motivates me. I consider myself a playful person, but as I have matured, my playfulness has developed from frivolous play into a more practical problem solving playfulness. I consider attempting to reintroduce bodily, carefree play into my and other young adults' everyday lives an important task, as I believe it can have various positive effects, besides making us more physically active. Secondly, I, myself, am a "victim" of the sedentary lifestyle that has come with the technological development of our time. My very close future largely consists of sitting by a desk, doing digital work. I saw this project as my last chance, during my studies, to try and make a positive change.

NTNU
Fakultet for arkitektur og design
Institutt for design

Master's Thesis for Sofie Margrethe Bjørnå

Holistic design approach to playful installation experiences

Holistisk designtilnærming til lekne installasjonsopplevelser

Modern technology has broadened our capacities well beyond our physical limits and made our lives increasingly comfortable, but had the unintended and worrying side effect of making our lives increasingly sedentary as well, with disastrous effects on health, mobility and well-being. The main hypothesis of the current project is that this trend can be reversed, and that digital technology designed for playfulness has the potential to transform our lives back from sedentary to active. The overall aim of the project is to contribute to an empirically based understanding of how we can develop and employ playful digital technology solutions in public spaces to promote and boost activity levels in adults.

During autumn 2019, a game installation meant for public spaces was built in collaboration between industrial design students and computer science students. This installation will go through an extensive test phase, where different configurations and modes of the game is tested with users. The test data will enable analysis of the different aspects of the installation and help create further understanding of playfulness in adults.

This master's thesis will include:

- Literature review on playfulness in adults
- Description of the prototype used in the test phase
- Holistic analysis of playful installation experiences from user testing
- A proposal for a playful installation design framework

This project is executed in accordance with "Retningslinjer for masteroppgaver i Industriell design".

Course supervisor: Ole Andreas Alsos (ID)
Additional supervisor: Yngve Dahl (IDI)

Starting date: January 9th 2020
Due date: June 4th 2020

Trondheim, NTNU, January 9th

Ole Andreas Alsos
Course supervisor

Ole Andreas Alsos
Head of Department

Summary

In this thesis, I investigate motivating and demotivating factors that influence users of public, playful installations, in order to create a better understanding of the user journey. This was done by taking a holistic approach to the entire user journey, considering physical, social and surroundings-related factors. The thesis includes the iterative user-centered design process of developing an installation prototype, and a summative assessment of the prototype. The installation underwent an extensive test phase, with 114 participants. Data was collected by conducting interviews, observations, data logging and a questionnaire. Based on the findings of the data collection, I conclude that the participants were motivated by a range of factors, where the most important are curiosity toward a new, unordinary activity, availability, audience entertainment, competition, variation, the demand for mental focus, and the possibility to improve strategies and beat the high score. The participants were demotivated by these most prominent factors: long waiting time, confusion toward the installation functionality and discouragement caused by an intimidating social setting. The reported factors and how they influenced the users throughout the user journey are systematized and visualized in the Playground Model. Additionally five guidelines are suggested: a) Facilitate learning, system comprehension and strategic development, b) Consider competitive elements, c) Consider social surroundings, d) Consider the installation location, and e) Ensure installation robustness. The model and the guidelines are suggested as a tool for designers and developers of installations of the like.

Sammendrag

I denne oppgaven undersøker jeg motiverende og demotiverende faktorer som påvirker brukere av offentlige, lekne installasjoner, for å skape en bedre forståelse av brukerreisen. Dette ble gjort ved å ha en holistisk tilnærming til hele brukerreisen, ved å vurdere fysiske, sosiale og omgivelsesrelaterte faktorer. Oppgaven inneholder den iterative brukerrettende designprosessen som ble brukt for å utvikle en installasjonsprototype, og en summativ vurdering av denne. Installasjonen ble brukt i en omfattende testfase, med 114 deltakere. Data ble samlet inn ved å gjennomføre intervjuer, observasjoner, datalogging og en spørreskjema. Basert på funnene av datainnsamlingen, kunne jeg konkludere med at deltakerne ble motivert av en rekke faktorer, hvorav de viktigste var nysgjerrighet mot en ny, uvanlig aktivitet, tilgjengelighet, underholdningsverdien for publikum, konkurranse, variasjon og kravet om mentalt fokus. Deltakerne ble demotivert av blant annet forvirring rettet mot installasjonens funksjonalitet og motløshet forårsaket av en skremmende sosial situasjon. Rapporterte forhold og hvordan disse påvirket brukerne gjennom brukerreisen er systematisert og visualisert i Playground-modellen. I tillegg foreslår jeg fem retningslinjer: a) Tilrettelegg for læring, systemforståelse og strategisk utvikling, b) Vurder konkurransebaserte elementer, c) Vurder sosiale omgivelser, d) Vurder installasjonens plassering, og e) Sikre installasjonens robusthet. Modellen og retningslinjene er foreslått som et verktøy for designere og utviklere av lignende installasjoner.

Table of Content

Chapter 1

Introduction

Digiplay is the working title for an initiative taken in collaboration between the Department of Computer Science and the Department of Design at Norwegian University of Science and Technology (NTNU). It is not an established concept, and it is not yet found in the literature. The term Digiplay describes the purpose of the initiative well, which is to investigate playful experiences created through digital technology. The main goal of Digiplay is to conduct research on the field of playfulness among adults, based on playful installation technology. As plenty of research has shown, the development of and growth in technology has made our lives excessively comfortable, while at the same time making us progressively sedentary. This lifestyle has a disastrous effect on health, mobility and general well-being. In an attempt to counteract this development, Digiplay aspire to take advantage of digital technology access to the contrary, and to explore the possibilities of reversing this worrying trend.

In this thesis I will attempt to contribute to the field of playfulness and public installations, by investigating how students at NTNU campus Gløshaugen interact with a digital, playful installation. I will look at what motivational and social factors that exist in the use situation with such installations, and how these factors influence users throughout the user journey. In order to collect data to discover and examine these factors, an installation was designed and built. This was done during the fall of 2019, in the course TPD4500 - Design 9 Specialization Project. Early during my work with the specialization project a question came to mind – is the user's experience with a game or an installation only depending on the installation itself? It was obvious to me that the answer to that question was "no, of course not", but what impact does the surrounding environment make? How does an audience, strangers or friends, shape one's experience with an installation? To what extent is the experience affected by the attitude and personal traits one enters into the activity with?

These questions and considerations culminates in the research question:

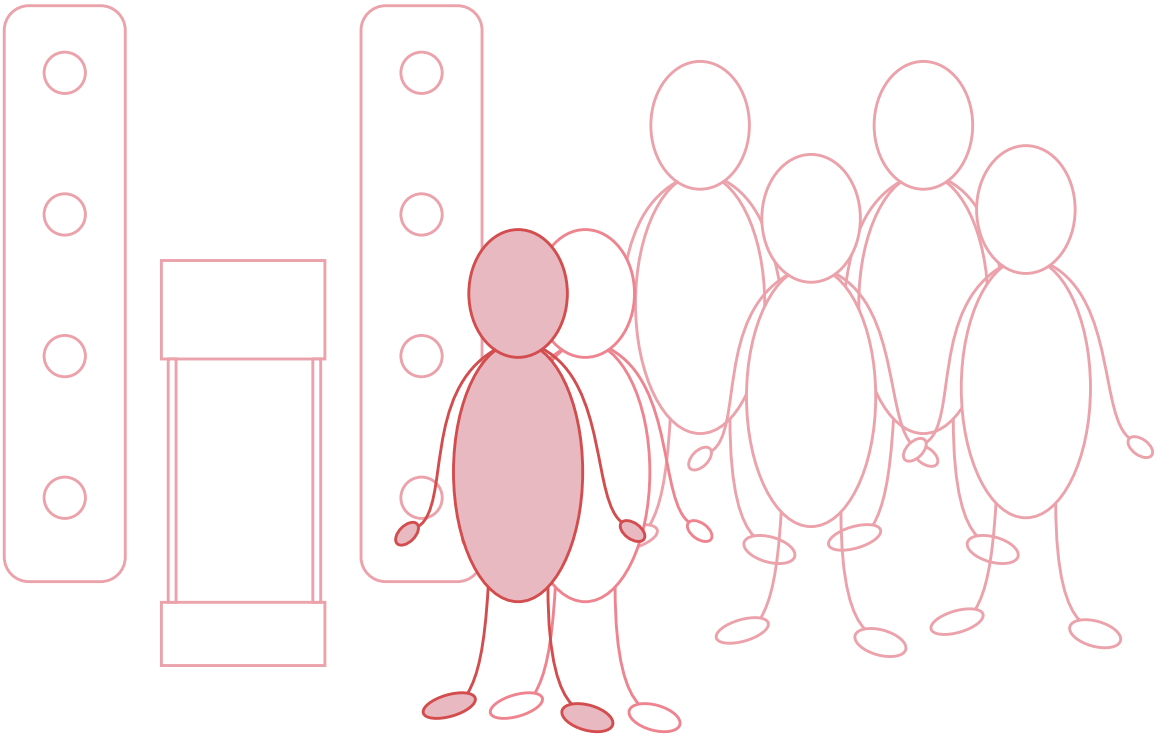
> *What factors, caused by social and physical surroundings, are present around the use of public, playful installations, and how do these influence the user's perception of the installation experience?*

The project will focus on healthy, young adults on university campus. The findings of this thesis are not meant to be applied to rehabilitation situations or work with e.g. elderly people. As a designer, I have chosen to focus mainly on the users' perceptions, opinions, feelings and experiences with the installation use situation, primarily in a qualitative manner, supported by quantitative data. In further research a more statistical or physiological approach can be used. The main contribution of this thesis is a model that puts motivational factors and social and circumstantial aspects into the context of the user journey through the installation experience. In addition to this, I present a set of guidelines/ lessons for future public installation designers.

This thesis consists of two parts. Part 1 describes our work with developing the installation prototype during the fall of 2019. Here, our design methodology – the double diamond, including user insights, definition of goals and the iterative development process is presented. In part 2, the research project, where the installation experience was examined with users, is presented. This part includes methods for data collection, data analysis and lastly a presentation and discussion of our findings related to playfulness, motivation and social factors. To understand the overall nature of the project, the thesis should be read in its entirety, but the two parts can be read separately.

Chapter 2
Theory

In order to understand preliminary work done in the field of playfulness and public installations, I conducted an examination of literature on the social factors around public installations and their impact on users, as well as the concepts of play and playfulness. I was mainly interested in studies that linked their findings to the user journey, as this would be of great benefit to my own research. Finke et al. (2008) and Wouters et al. (2016) present models on user behaviour in relation to an interactive public installation, called respectively User Interaction Framework and The Honeypot Model.



2.1 User Interaction Framework

Finke et al. (2008) present a user interaction framework for experiences with public installations. Their research is based on an interactive game using large digital displays in public spaces for shared entertainment. Firstly they divide the user group into actors, spectators and bystanders, as illustrated in Figure 2.1. They describe the bystanders as people who have no or little interest in the display or its content. The spectators are engaged with the display, but are not active manipulators of its content. Actors are actively manipulating or controlling the displayed content. Finke et al. describe their goal as ultimately transforming both spectators and bystanders into actors. This challenged their design approach to pay attention to the bystanders' needs, to make the transition to a contributing role easier.

From this, they developed a user interaction framework. This allowed partitioning different design problems in relation to the motivations of the audience of the display. The framework consists of seven interrelated stages, as illustrated in Figure 2.2. First-time display users will have to go through all seven stages, but naturally only a part of all the people that enter will make it all the way through, as some will have a temporary or permanent stop in the bystander or spectator section. This model does not include which factors lead to activity drop out, or social and interpersonal factors that may affect potential actors.

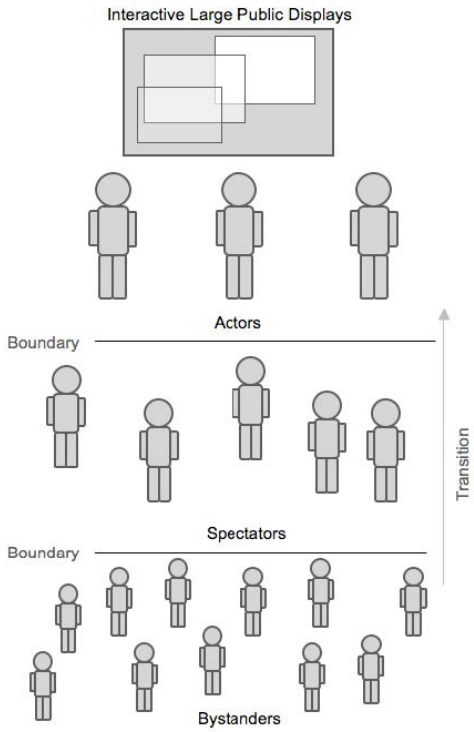


Figure 2.1. Actors, spectators and bystanders as users in a public space (Finke et al. 2008)

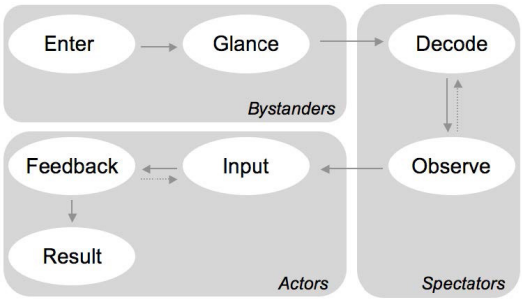


Figure 2.2. User interaction framework (Finke et al. 2008)

Based on their observation of user behaviour with the installation Polar Defence and previous work, Finke et al. identified the following criteria:

a. *Support observational learning through simulated users in lieu of real users.* Bystanders should have the ability to learn the functionality of the installation through observing others use or simulations of it.

b. *Employ a simple trust model by judiciously communicating system state.* Users of the system must be able to trust and understand the purpose behind the installation, and understand the potential cost of interaction. This also includes the need of trust in the installation to function properly.

c. *Allow users to control how their actions are exposed to bystanders.* The system should not force users to behave inappropriately in order to interact.

d. *Providing features supporting asynchronous competition can drive use of public displays.* Users should be able to track their and others' score. This can be done with e.g. "persistent high score list".

2.2 The Honeypot Effect

The honeypot effect is, according to Wouters et al. (2016), a phenomenon in Human-computer interaction (HCI) that "describes how people interacting with a system", such as a public installation, "passively stimulate passers-by to observe, approach and engage in an interaction." This means that if there are people interacting with a public system, their interaction and activity will stimulate potential users to approach the system themselves. The term especially applies to unordinary activities that may appear moderately embarrassing or exposing to the user, which can be made more socially acceptable by the engagement of other people.

If they are doing it, why cannot I?

Wouters et al. investigated the honeypot effect with a public interactive system called the *Encounter*. From their in-the-wild field study, they developed the Honeypot Model (Figure 2.3), which describes the different stages of approaching a public installation, and what decisions are made in transition between the stages. Contrary to the user interaction framework of Finke et al., Wouters et al. take social and interpersonal factors into account by e.g. highlighting the value of being part of the audience before taking active part in the activity. Factors leading to dropout are also included. Wouters et al. found that there needs to be a balance where the amount of audience members have to be enough to attract more users, but not too much so that the players or actors feel intimidated or distracted by the audience. This balance is what Wouters et al. call the honeypot "sweet-spot". In addition to the model, Wouters et al. conclude with a set of guidelines for the facilitators or designers of similar public installation:

a. optimizing the physical environment, by considering a range of ergonomic, spatial, technical and social aspects;

b. deploying triggers to ease transitions between user roles;

c. stimulating opportunities for collaborative interaction, peer learning and exploratory activities;

d. allowing for dropouts to leave without any repercussion, or empowering them to reactivate within the activation loop and to stimulate those who have yet to engage.

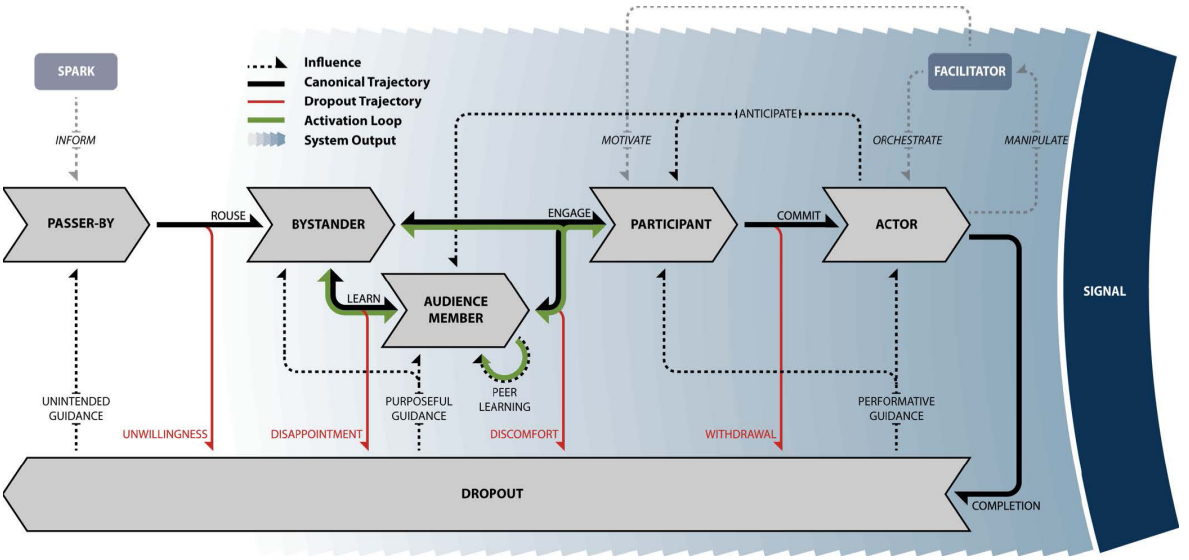


Figure 2.3. The Honeypot Model developed by Wouters et al. (2016). User roles are described in Table 2.1

Table 2.1. User role descriptions

User Role	Description
Passer-by	Roams around the immediate vicinity of an interactive system, or learns about installation from triggers outside installation vicinity.
Bystander	Has experienced some form of (distant) visual, sonic, tangible or spatial expression of the interactive system. Still unaware of the true purpose or features of the system.
Audience Member	Is familiar with the interactivity and the social norms surrounding a system. Learns from watching participants and actors, and from discussing with other audience members (peers).
Participant	Exhibits subtle forms of engagement with a system. Is building a sense of comfort, but is still not fully committed to the activity.
Actor	Demonstrates some committed form of engagement. Engagement shown through more complex interactions, extended time or effort of interaction.
Dropout	Has abandoned engagement with the system. Dropout can happen from any user role, even without any interaction.

2.3 Play and Playfulness

The various definitions of *play* and *playfulness* proposed by multiple authors, through decades, show that a broad scope of activities can be considered playful. The concept of play itself is an ambiguous concept with a collection of diverging approaches, theories and definitions. (Korhonen et al., 2009)

Authors agree that play is a fundamental part of childhood, as it is through play that children develop skills that will help them master their environments. Motor skills, coordination and body control are highlighted as important factors that are improved through play in early life (Frost, 1998). Infants and children are dependent and in need of care. Parents or other caregivers therefore become the facilitators of play. When children evolve into adolescents and adults, they need to find their own structure for playful behaviour. Additionally, as play is associated with children, the threshold for adults to participate in play by themselves is relatively higher.

There has been a void in the research conducted on playfulness, especially regarding playfulness in adults. Authors agree that playfulness carries on into adult life (Guitard et al., 2005; Lieberman, 1977; Solnit, 1998) in some form. Solnit (1998) claims that adult playfulness is evident through properties such as creative problem solving and useful imagination. Lieberman (1977) suggests that the social manifestation of play is less acceptable for adults. Olsen (1981) and Piaget (1951) claims that playfulness, in adults, lacks a clear practical usefulness, and that playfulness is perceived as an unnecessary or even insipid personality quality for the rational adult mind. This may be a cause for the inadequate research on adult playfulness.

> "The past three decades have seen a growing number of studies focused on the functions and benefits of playfulness in adulthood by associating it with health or productivity indicators, including tension release, increased group cohesion, boredom alleviation, and improved performance in the workplace." (Shen, Chick & Zinn, 2014)

Burghardt (2005) proposes five criteria to distinguish play from other activities, and claims that "all five criteria must be met in at least one respect before the play label can be confidentially attached to any specific instance of behavior". The five criteria are as follows:

1. "[...] the performance of the behavior is not fully functional in the form or context in which it is expressed; that is, it includes elements, or is directed towards stimuli, that do not contribute to current survival."

2. "[...] that the behavior is spontaneous, voluntary, intentional, pleasurable, rewarding, reinforcing, or autotelic."

3. "[...] that it differs from the 'serious' performance of ethotypic behavior structurally or temporally in at least one respect: it is incomplete (generally through inhibited or dropped final elements), exaggerated, awkward, or precocious; or it involves behavior patterns with modified form, sequencing or targeting."

4. "[...] the behavior is performed repeatedly in a similar, but not rigidly stereotyped, form during at least a portion of animal's ontogeny."

5. "[...] the behavior is initiated when an animal is adequately fed, healthy, and free from stress (e.g. predator threat, harsh microclimate, social instability) or intense competing systems (e.g.,feeding, mating, predator avoidance). In other words, the animal is in a 'relaxed field'."

Salen and Zimmermann (2004) states that play is "free movement within a more rigid structure", which very well suits the purpose of the project presented in this thesis. Play is often associated with pleasure, as in Burghardt's second criteria. Groos (1901) claims that whenever "an act is performed solely because of the pleasure it affords, there is play". Rudan (2013) states simply that "The attempts of defining play have mainly relied on its negation, i.e. on the establishing of what play is not – work."

Lucero, Karapanos, Arrasvuori & Korhonen (2014) present the Playful Experiences (PLEX) Framework. It consists of 22 categories that describe playful experiences (Table 2.2).

Table 2.2. PLEX categories

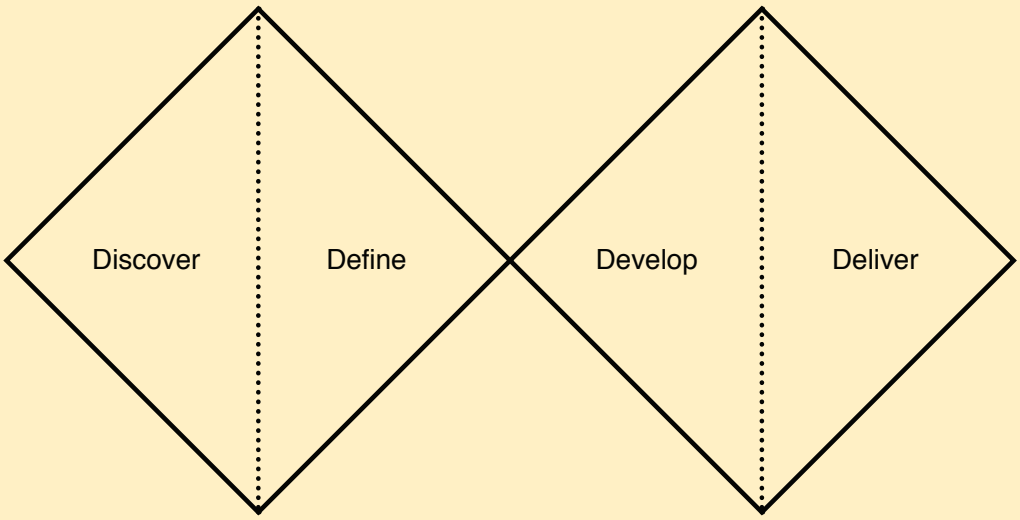
Experience	Description
Captivation	Forgetting one's surroundings
Challenge	Testing abilities in a demanding task
Competition	Contest with oneself or an opponent
Completion	Finishing a major task, closure
Control	Dominating, commanding, regulating
Cruelty	Causing mental or physical pain
Discovery	Finding something new or unknown
Eroticism	A sexually arousing experience
Exploration	Investigating an object or situation
Expression	Manifesting oneself creatively
Fantasy	An imagined experience
Fellowship	Friendship, communality or intimacy
Humor	Fun, joy, amusement, jokes, gags
Nurture	Taking care of oneself or others
Relaxation	Relief from bodily or mental work
Sensation	Excitement by stimulating senses
Simulation	An imitation of everyday life
Submission	Being part of a larger structure
Subversion	Breaking social rules and norms
Suffering	Experience of loss, frustration, anger
Sympathy	Sharing emotional feelings
Thrill	Excitement derived from risk, danger

2.4 Application of Theory

The theory presented in this chapter is meant for different applications. The theory on the two models was used in order to understand preliminary work in the field of user experience with public installations. The Honeypot Model (Wouters et al. 2016) was used as inspiration for the Playground Model presented in Chapter 10. Application of Results.

The theory on play and playfulness is presented in order to create an understanding of the concept of play and its many aspects. This laid the foundation for the installation development presented in Part 1: Playful Installation Prototype.

Part 1:
Playful Installation Prototype



In Part 1 of this thesis, I will present the design process of developing the installation prototype. The process is methodically described by the Double Diamond design process. The Double Diamond is divided into four steps:

a. **Discover:** The solution scope is broadened by gaining insight into the domain of the project and exploring and analysing user needs and existing solutions

b. **Define:** Findings from the discovery phase are evaluated and the scope is narrowed by defining a set of requirements and goals for the solution

c. **Develop:** The scope, based on the set requirements, is broadened again to generate various ideas, before starting an iterative process where solutions are developed, tested and evaluated

d. **Deliver:** By iteratively improving and defining the prototype, the scope is narrowed until the final solution meets the set requirements

Chapter 3
Discover

The solution scope is broadened by gaining insight into the domain of the project and exploring and analysing user needs and existing solutions.

The ideation phase was spent using different sources to find inspiration for game concepts. This included both analysing existing solutions and asking our peers about their preferences and ideas. The methods described below were used in the prototyping phase to inspire and to validate or deny our assumptions, and to test the overall usability of the prototype.

3.1 Analysis of Existing Concepts

Profezzzor McSlap

During the spring of 2019, another class at the Department of Design had developed several installations for playfulness. Each of the project groups behind these installations had written blog posts about their design and development processes, which were very useful to us in our inspiration phase. Luckily, one of these installations, Profezzzor McSlap ("Profezzzor McSlap", 2020), was not yet dismantled. This let us do a thorough analysis by asking ourselves these questions:

- Why is it entertaining?
- How does the installation accommodate an audience?
- Are there any annoyances for the player during the game?
- What motivates physical activity?
- And is the game self explanatory?

We also had a look at the code (which they kindly shared with us) and the wiring of the arduinos, LED-lights, seven segment displays and micro switch buttons (Figure 3.1).

Profezzzor McSlap had a fairly clear narrative, which students could easily relate to. As the player, you were in the role of a professor, teaching a class of green, alien-like students. As time passed, the students fell asleep, represented by their silicone faces falling down. To keep them awake, you had to do the task of slapping their faces, so that the metal plate on the backside of the head was caught by the electromagnet mounted in the wooden back panel. For each student you woke up, points were collected, which were shown on the seven segments on top of the installation. After a while, the opportunity to take a quick coffee break arose, giving you a short pause to breathe, but eventually, when four students were asleep at the same time, the game was over.

Figure 3.1. Examination of Profezzzor McSlap.

This game became quite popular among the students at the Design Department, and people gathered around to beat the high score. The installation was a great crowd pleaser, because of the humorous concept and the player's freedom to be creative in their slapping and to create their own strategies. The rapidity of the game and the distance between the faces motivated physical activity well. The game facilitated player development, where players could improve their score over time, making it more likely that people would play more than once. The game was not completely self explanatory, e.g. the start-button was not obvious. Also, the high placement of the scoreboard, made it hard to see your score mid game.

Main takeaways:

- Narratives are great, if they are clear
- High score motivates repetition
- Being in the audience is fun, if the activity is entertaining
- Facilitation for creative task solving made the activity both physical and fun
- Messy wiring complicates troubleshooting
- Electromagnets may become very hot (fire hazard)

Visit to Vitensenteret

Vitensenteret is a science center in Trondheim where visitors can explore phenomena from the world of physics through a variety of installations. They make many of their installations themselves in their maker space. Others are made on order from various manufacturers. Vitensenteret welcomes audiences in all age groups, but the majority of visitors are children and school classes. To ensure that the installations will pass the test of time and children's sometimes incautious handling, they have to be robust. Therefore their largest installations are constructed with metals and wood rather than plastics (See example in Figure 3.2). Our contact there, Nils Kristian Rossing (Figure 3.3), also told us about their experience with making certain installations stand out to attract users, and shared some of their tricks with using colors and materials. From our field trip to Vitensenteret, we experienced that many installations became less approachable because we had to read long instructions in order to execute the activities correctly.

Figure 3.2. Example of installation from Vitensenteret. (Vitensenteret.no, 2020)

Figure 3.3. Nils Kristian Rossing from Vitensenteret.

3.2 Understanding the User

Interviews: Student Break Modes

The installation presented in this thesis was developed to facilitate active breaks for students on university campus. In some places around campus there are opportunities for break activities, such as foosball and ping pong tables, but these are only used by a fraction of the student body. We wanted to know how students spend their breaks, and if they are satisfied with the physical activities available on campus. We went to an area on campus with many lecture halls close to each other during a 15 minute break, where we conducted informal interviews with students out in the hall and inside the lecture halls.

For the students leaving the lecture halls we asked what they were doing, where they were going and why they felt the need to leave the lecture hall. Their reasons were typically that they wanted some fresh air, wanted to chat with their friends, needed something from the kiosk, had to use the bathroom or wanted to check out company stands in the hall for free stuff or coffee. From those who were left in the lecture hall, the answers were that they wanted to just scroll on their phone, check their emails, take a short power nap, repeat the material that had been lectured, or simply wanted some peace and quiet. None of the people we talked to went out of the lecture hall or mentioned any desire to engage in any sort of play or game, even though they had access to it in that area. When directly questioned, some said that the activities nearby were always occupied by others, and the activity lasted too long for them to wait in line.

The interview findings indicated that most students are not interested in participating in the existing activities on campus or that the current offer of activities is not satisfactory or available enough.

The goal for these interviews was to create a set of personas, but we saw that people's break habits varied from day to day, depending on mood and schedule. Their needs for break activities also depended a lot on the activity they were taking a break from: If the lecture was boring, the need for fresh air, social interaction or physical activity was stronger. That's why we developed a set of what we chose to call break modes (Figure 3.4). The modes do not describe a complete, typical student, but moods or modes where students can relate to one or more.

The left three modes (The Player, The Chatter and The Hunter) are active break-takers. They engage either in physical or social activity. The three to the right (The Scroller, The Napper and The Lotus) are more passive, with no physical activity (may even stay seated in the lecture hall) and virtually no social interaction, except for the scroller who may talk to someone on social media.

There is no right or wrong way to take a break, and all of these may be effective methods. Any student may shift between different modes at any time.

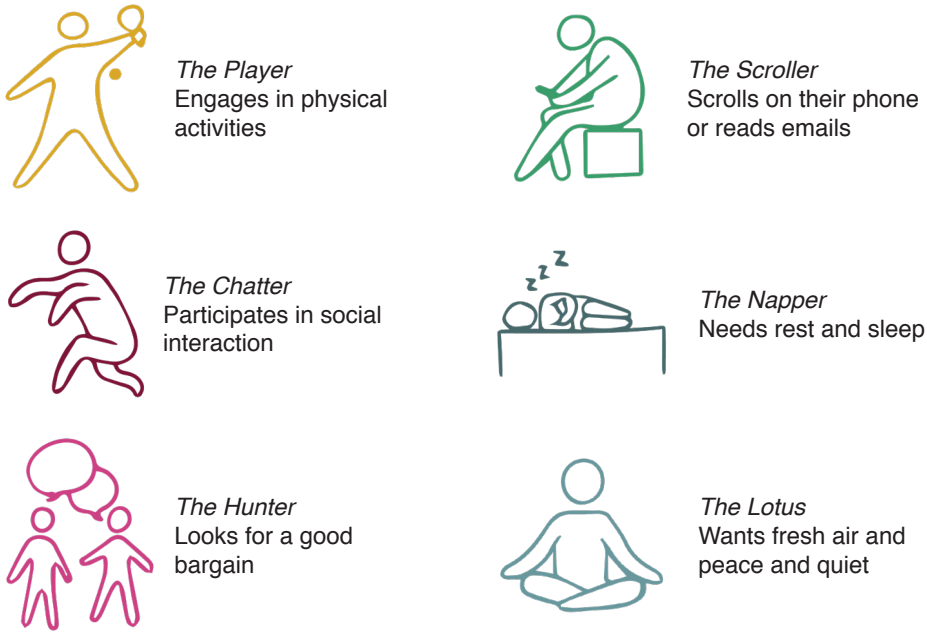


Figure 3.4. Student break modes.

Graffiti Wall

In order to understand students' associations with playfulness and playful physical activities, we asked for their input on the matter. This was done by Graffiti Wall-ing (Hanington and Martin, 2012). Playfulness is mainly associated with children and childhood. Therefore the question "Except from organized sports, what was your favourite physical activity as a child?" was written on a whiteboard placed in the Department of Design common area and left there for approximately a week. The question was formulated in such a way to avoid common answers like soccer or handball, which we in advance considered as unnecessary information to our research. We were looking for unorganized, spontaneous and playful activities associated with childhood. This method let people give their opinion without having to elaborate on the reason behind it and they could choose whether or not to participate. They could read the question, think about it for a while and then respond if they wanted to, and be anonymous in their response. An inconvenience related to this method was our inability to further investigate what exact parts of the different activities that made them favourites. It did, however, generate a list of activities we could be inspired by and gather functionality from in our ideation phase. The result of the Graffiti Wall is shown in Figure 3.5.

Main takeaways:
The majority of the activities
- did not have an established set of rules
- did not require any equipment, or easily available equipment, e.g. a ball
- could be performed spontaneously
- should or could be performed together with others

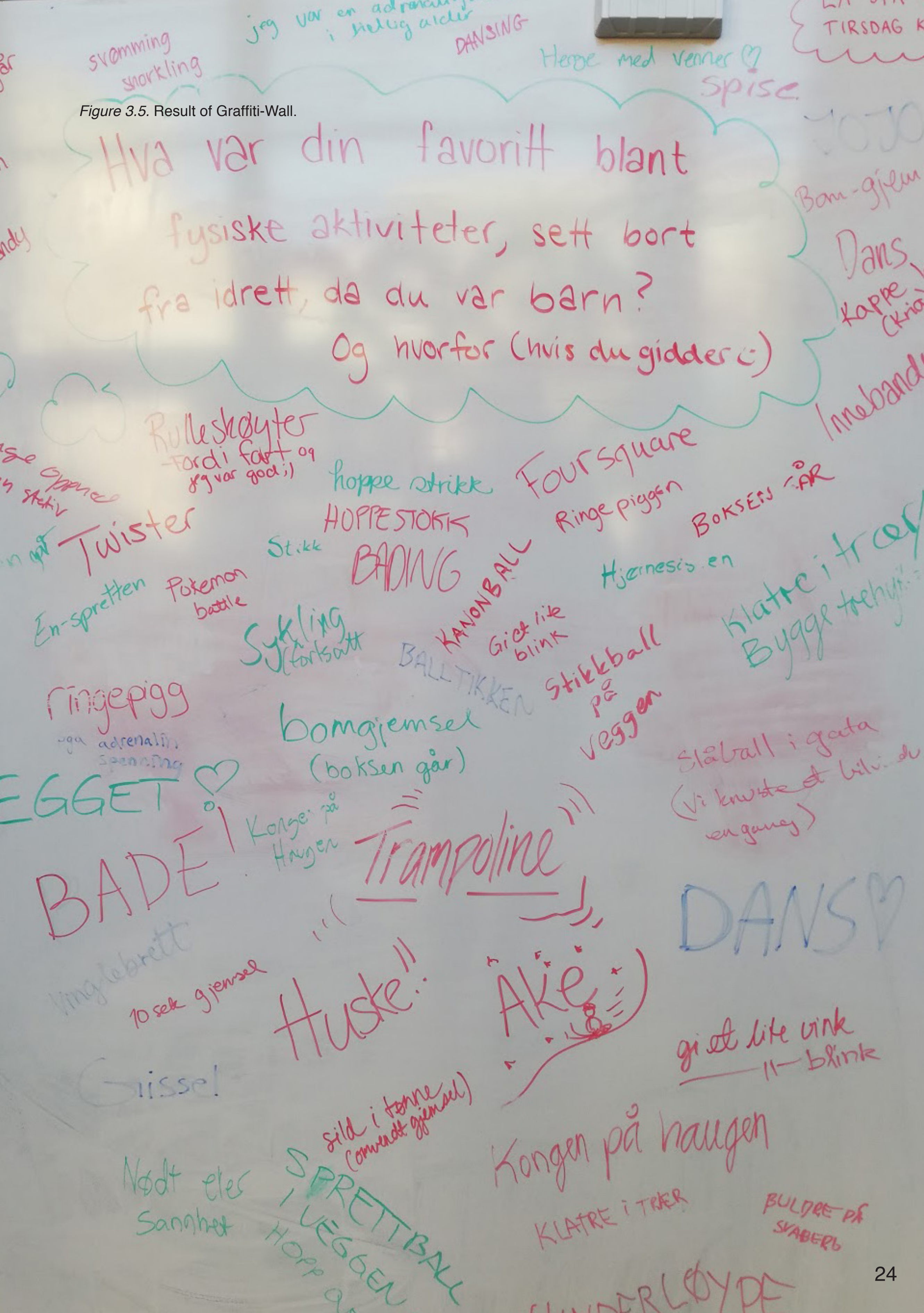


Figure 3.5. Result of Graffiti-Wall.

3.3 Learning Game Development

Visit to Game Studio

Studio Gauntlet is a small game design business in Trondheim, founded by Industrial Design alumni. During the development of their video game Bonkies, they have acquired a solid expertise in game design, game loop development and in-game sound design. We met with industrial designer and game developer Christer Rebni to gain insight in how to use sound well in our game and get their opinion and advice on game loop structure. From this we learned that sounds can be a crucial part of game design, as it, in addition to visual effects, gives feedback to the player, but can also enhance the mood or environment for the game in total, especially in video games. They gave us very useful input on what types of sounds that could fit with the game we had in mind, and which kind of sound effects to use for different situations and where to find them. In retrospect, we have realised that they gave us a rather important warning, though, about using sound effects with the Arduino microcontroller, as their experience was that the Arduino can be quite difficult to program well for audio purposes. For the game loop, they also gave valuable feedback and advice on how to build a structure that on-boards the player well, and how to create progression and surprise elements throughout the game.

Game Design Crash Course

Trond Are Øritsland teaches game design at the Department of Design at NTNU. We consulted him to help us understand how to build the design of the game loop well. He suggested that we should include what he called the "James Bond opening" that takes the users straight into the action, without overwhelming them. He also advised us to include some sort of game functionality that gives the users a break within the game, to motivate for a longer engagement and make the game less exhausting. In this break, the possibility to "die" should be eliminated. Beyond this, the intensity and increase in difficulty should be in line with the desired playing time. A visualization of the suggested development difficulty level is shown in Figure 3.6.

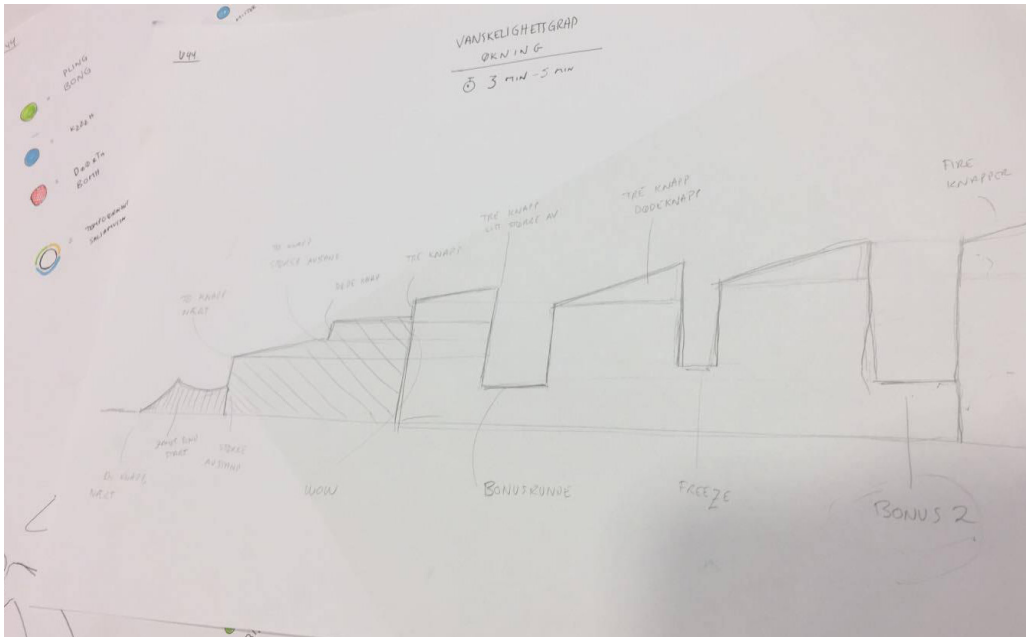


Figure 3.6. Visualization of learning from crash course.

Chapter 4
Define

Findings from the discovery phase are evaluated and the scope is narrowed by defining a set of requirements and goals for the solution.

When starting out with a new project, one can easily go ahead with an idea without thinking about what you are doing or where you want to go with it. To avoid this, it was important to us to specify what we wanted to achieve with the installation, what elements we wanted to include, what we wanted to prioritize and why. In this way, we were able, at any time, to measure what we made against our own requirements throughout the process, thereby justifying choices and decisions, and being critical to our own work. This helped us avoid major derailments and to focus on the most important aspects of the project. The requirements below were set based on what we had seen in our research (e.g. key takeaways), both through existing installations, playfulness theory and our own desires for personal learning and exploration.

4.1 Requirements

Encourage Playful Behaviour

Different Modes for Different Number of Players

The motivation behind this entire project was to research playfulness in adults in relation to public installations. As Lieberman (1977) suggests, the social manifestation of play is less acceptable for adults. Being able to engage in playful activities together with others may contribute to lowering the threshold for participation. Doing out of the ordinary activities with a friend can be less frightening than doing it alone, as one may not feel as exposed to for example an audience. Letting people play together may also make the installation a social arena, where friends can explore and have fun together, or where strangers can engage in a common activity and focus on solving the installation tasks without having to do potentially awkward small talk. We wanted the installation to offer different game modes to accommodate different numbers of players.

Freedom to Develop Strategies and Tactics

A key aspect of playfulness is the spontaneity, the freedom to explore and not being bound by a rigid set of rules. We wanted our game to be perceived as play, as an activity where it does not matter too much if you win or lose, succeed or fail. Maybe we could even eliminate the feeling of failure completely, because users were having fun either way. The focus should not be on the rules, but on trying to solve the tasks within the game creatively and by your own tactics. The game should facilitate the possibility to develop your own tactics over time, thus letting players evolve and improve, and feel a sense of progress and accomplishment.

Audience Entertainment

Watching others play should also be entertaining in itself. When seeing someone else having fun and laughing, most people are motivated to join in and become active participants themselves. This may work as an automatic recruiter of new players, by creating buzz around the installation and maybe triggering people's fear of missing out. However, playfulness and the urge to try physical activities are not as strong in everyone. Being in the spotlight may also be an obstacle for some. Regardless, people should have the opportunity to enjoy the installation without active participation.

Short Game Session Duration

The installation would be used mainly during 15 minutes breaks between lectures, and the game should last even shorter than that, to allow multiple people to play within the same break. An approximate goal of 2-3 minutes game duration was set.

Absence of Narrative

When analysing the Profezzzor McSlap installation, we were determined that our installation should have an equally entertaining narrative. This proved not to be easily feasible. For a narrative to work, it must be possible to relate to and recognizable to all potential users, and it must be clear and appropriate for the installation. An absence of narrative will allow a greater scope for imagination and interpretation by the user, and possibly to a greater extent facilitate playfulness. The narrative of Profezzzor McSlap worked because it was clear and fitting for its surroundings and location, and also because many of its users had seen the narrative film that was produced to explain the concept.

Self Explanatory

We wanted the game to be self explanatory and with no written communication, not even a "Press here to start"-sign. To achieve this, the functionality must be obvious and intuitive, or easy to learn either during one's own play, or by watching others play. The installation should not require experience with similar systems and should follow common design principles for interaction.

Tactility

The prototype should offer a physical user interface with tactile elements, without using digital screens. We knew that the game would include some sort of button, and to invite users to play, we wanted the buttons to be tempting to touch, to trigger curiosity and motivate users to interact. Buttons themselves are titillating, and for some reason we want to touch them. Buttons promise some sort of result, and not knowing what that result is can be unbearable for some people. To attract users, creating that tactile temptation could be helpful. Also, making an installation that is pleasurable, and at least not harmful, to touch should be pursued.

Strong Visual Appearance

Students at NTNU are quite targeted as they walk through the hallways on campus. They usually have a place they need to get to, so a little noise is required to catch their attention. To do this, the installation needed to create a visual impact, with LED-lights and an eye-catching design. However, we did not want the installation to be flashy and visually loud to the point of annoyance. To make the installation feel inviting and friendly, and also to provide a natural implementation in potential locations outside NTNU, we wanted to incorporate elements of Scandinavian design into the structure. It was emphasized to choose materials with contrasting qualities that harmonize together, such as matte aluminium and natural wood. The Scandinavian qualities could be further enhanced with a form language with rounded corners, which additionally invites tactility in the product.

Robust Prototype

Even though our prototype would never operate unattended, we would rather not have to fix errors or damage to the prototype during the data collection phase. This placed requirements on both the physical prototype, the wiring and the code. As the installation should promote physical activity, we assumed that the installation would have to endure forces applied by users, which were beyond our control. Additionally, we did not want to restrict our participants to be careful. We wanted the participants to interact with the prototype as if we were not there, so we hoped that the prototype would communicate a robustness to ensure the users that it could withstand almost whatever force they wished to use.

Exploiting Digital Technology

Even though the installation should not use digital screens in any way, the installation still had to be digital. Therefore, some sort of technology, such as an Arduino, Raspberry Pi or microcontrollers of the like, must be used. It was decided that Arduino was the best option based on the competence of the project team.

Debugability

From earlier projects, we had all learned the hard way that it is almost impossible to do everything right the first time, and that troubleshooting quickly becomes an important element in such projects. Almost any problem can occur in either the code, the wiring or in the Arduino itself, or a combination of the three. Being able to easily detect where these inevitable errors occur can save enormous amounts of time, especially early in the process where the most frequent errors are not yet easily recognizable.

One of the most annoying reasons for tedious troubleshooting is messy wiring. If the inside of a prototype looks like a bowl of colorful spaghetti, you can brace yourself for a frustrating search party if an error occurs. The same thing goes for the code – if the code is tidy, it is much easier to detect mistakes. For the Arduino itself, it was important to us to use proper Arduino brand Arduinos, and not Chinese knock-offs, as they more often than not are problematic or faulty.

Audio Feedback

We knew from before that working with Arduinos and sound could be difficult, but we still wanted audio feedback in the game, as an additional source of feedback. This was not, however, given the highest priority simply because it was not considered a fundamentally necessary element to a working game. We also knew it would require many hours of work, and we had to ensure that the most essential elements were in place first. Using a Raspberry Pi microcontroller instead was discussed, but as none of the team members had sufficient experience with it, we decided to make it with the Arduino or not at all.

Chapter 5
Develop

The scope, based on the set requirements, is broadened again to generate various ideas, before starting an iterative process where solutions are developed, tested and evaluated.

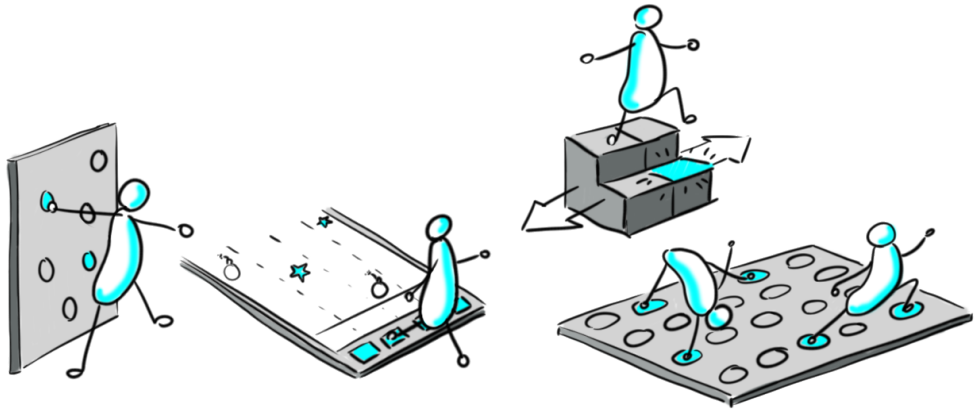


Figure 5.1. Excerpt of ideas from ideation workshop.

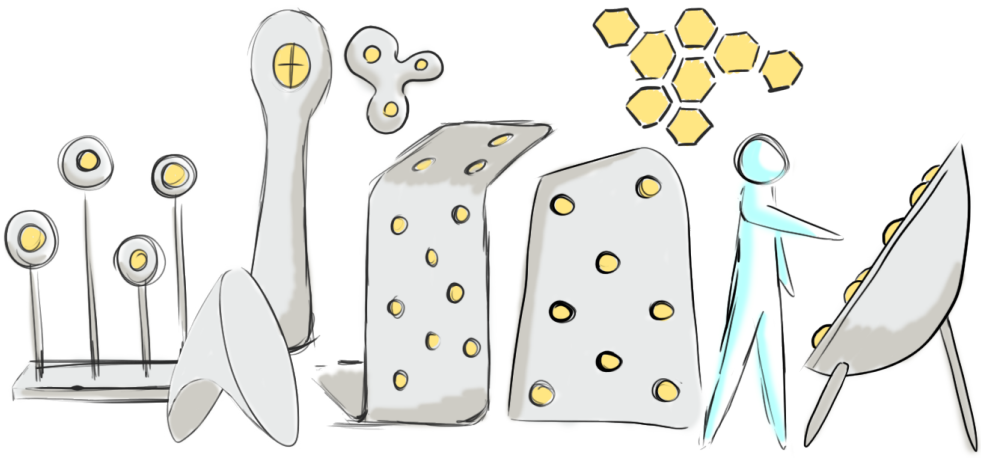


Figure 5.2. Further detailing of ideas.

5.1 Ideation

Ideation workshop

After setting the requirements presented in Section 4.1, for the installation, we started sketching potential concepts. We wanted a broad range of ideas to choose from, so we tried not to be too restricted by these during the ideation phase. We thought that whatever the concept we came up with, it could be further developed to meet the demands we had set for it. The concept sketching was done in 20 minutes sprints with the goal to generate as many ideas as possible within that time. After the sprints, all ideas (Figure 5.1 shows an excerpt of these) were discussed and a few were picked out for further ideation and detailing. Further elaboration on these resulted in two promising concepts: An elevated cube with buttons placed around its faces, and a set of poles with buttons, which could be arranged in various formations (Figure 5.2 and 5.3). These were then discussed in relation to the requirements for the project.

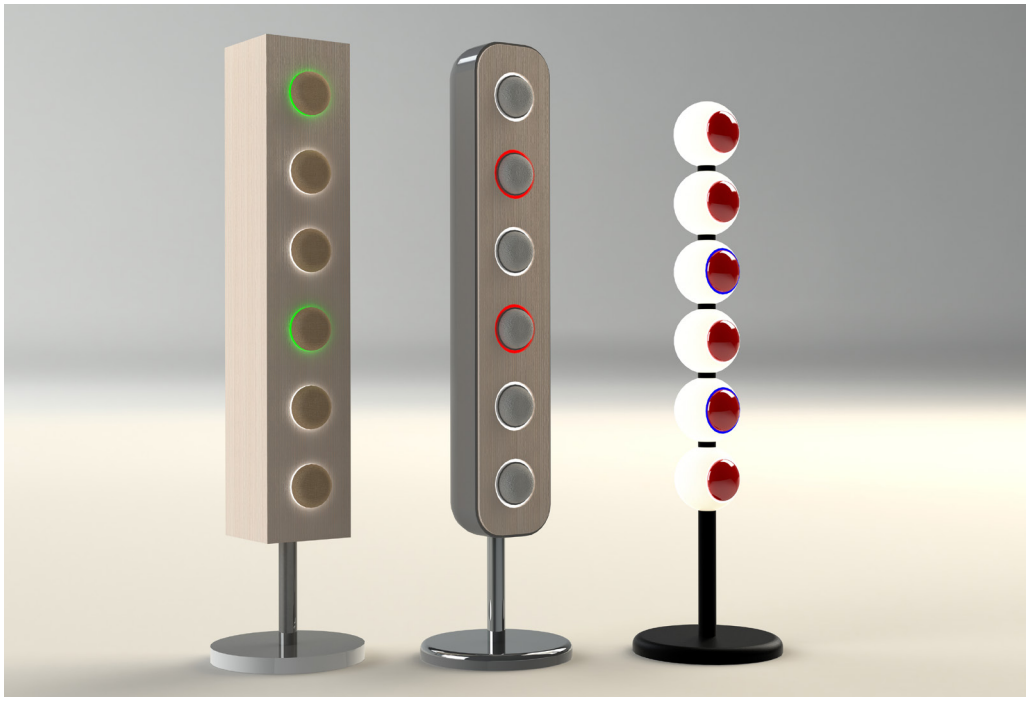


Figure 5.3. Initial concept alternatives visualization. Render from SolidWorks.

5.2 Iteration 1: Trying Out the Concept

Low Fidelity Prototype

The poles were considered to be the concept with the greatest potential to meet the requirements we had set for the project, and where the scope of opportunity was greatest. From there, it went into a rapid prototyping session, creating a low fidelity prototype, with a Wizard of Oz test (Hanington and Martin, 2012) in mind.

The prototype consisted of two MDF boxes measuring 850 x 150 x 70 mm. Each pole was equipped with four fake buttons, made with various MDF and wooden pieces and a steel spring. Each button was surrounded by an LED-ring (Figure 5.4). These buttons did not register input, but the LED-rings were programmed to run a realistic game loop, and could be turned off by the research team. The LED-rings were programmed with two modes: A countdown functionality where all diodes in the ring lit up in green, before the diodes, one by one, were turned off to simulate that the time was running out, and a red button which should not be pressed. The prototype was considered a minimum viable product, enabling us to quickly test the concept and get feedback from users.

Wizard of Oz Test

The prototype was guerilla tested (Hanington and Martin, 2012) with students from the Department of Design, with the aim to validate the general game concept for further development. We wanted to

- explore and test the concept,
- observe how users interact with the prototype,
- test gameplay patterns and
- receive general feedback and suggestions for further development.

The prototype used in this test was only partly functional, meaning that the LED-rings were programmed with an actual game loop, while the button functionality was simulated by a member of the research team. The Wizard of Oz test setup is illustrated in Figure 5.5. We tested two different setups, poles standing up and lying down on the table, just to test if a longer, horizontal movement pattern was more fun.

After trying the prototype, test participants gave their feedback on the installation. We also asked the participants to fill out a modified System Usability Scale (SUS) (Appendix A) (Sauro, 2011) form afterwards.

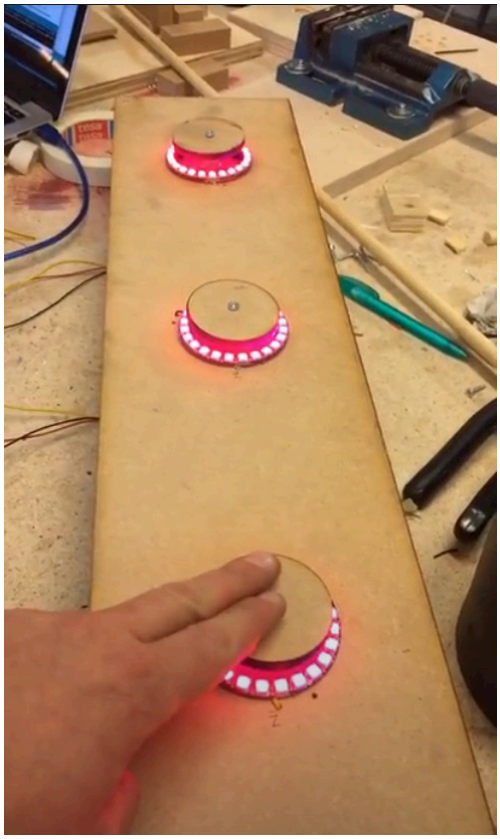


Figure 5.4. Rapid prototype made of MDF, with fake buttons.

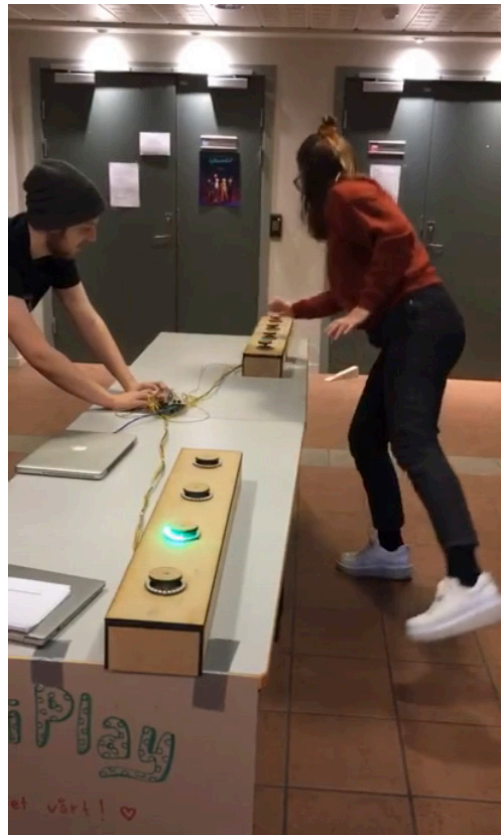


Figure 5.5. Test of poles lying on table. Project team member in the role of the *Wizard* is shown to the left.

Table 5.1. Summary of feedback from Wizard of Oz test.

Element	Feedback/Suggestion
Dimensions	Poles should be taller and wider to allow larger buttons and to increase bodily movement and difficulty level. Many test subjects were observed standing almost completely still, only using their peripheral vision and outstretched arms.
Buttons	The buttons should be bigger to facilitate pressing. The LED-rings should be in/on the button itself, to ensure visibility of diodes from all angles. The countdown function should include a gradual change in color from green to orange/red. Other button modes were suggested, such as red = minus points, blue = freeze mode, rainbow = extra points. Four buttons per pole was considered suitable.
Game Loop	The difficulty level/speed of the game should increase with time.
Collaboration/ Competition	The game had to be very difficult for collaboration to be necessary and relevant. Competition and high score were highlighted as more desirable aspects.
Sound	The game should include auditory feedback, e.g. when pressing buttons or when achieving a goal.
Score	The installation should let the player keep track of how well one was doing in the game, in the form of a life indicator or a scoreboard.

Evaluation and Feedback

The test, both through oral feedback and the SUS score of 77, gave good enough results to continue work on the concept. All participants seemed to be having fun. Some improvements and potentials were suggested as summarized in Table 5.1.

This test was also done to confirm our color semantics assumptions, and the meaning of these were interpreted as we wished. The test did not, however, include any participants with color blindness. We were therefore not able to test if the red and green button modes were distinctive enough.

5.3 Iteration 2: Developing for the Spatial Context

Choice of Location

The prototyping phase presented some challenges in terms of placement of the installation. The initial ideation phase resulted in a concept involving *freestanding* game poles. While not impossible, the construction of such pillars, with the necessary weight in the foot to withstand the applied force of button presses, was considered too complex and time consuming to be done within the project timeline. It was therefore decided that this concept could only be carried out as a prototype that could be mounted onto a wall or the like. Also, to ensure efficiency in the data collection phase, it was necessary that the prototype could be assembled quickly, and put away between test days to avoid damage to the installation.

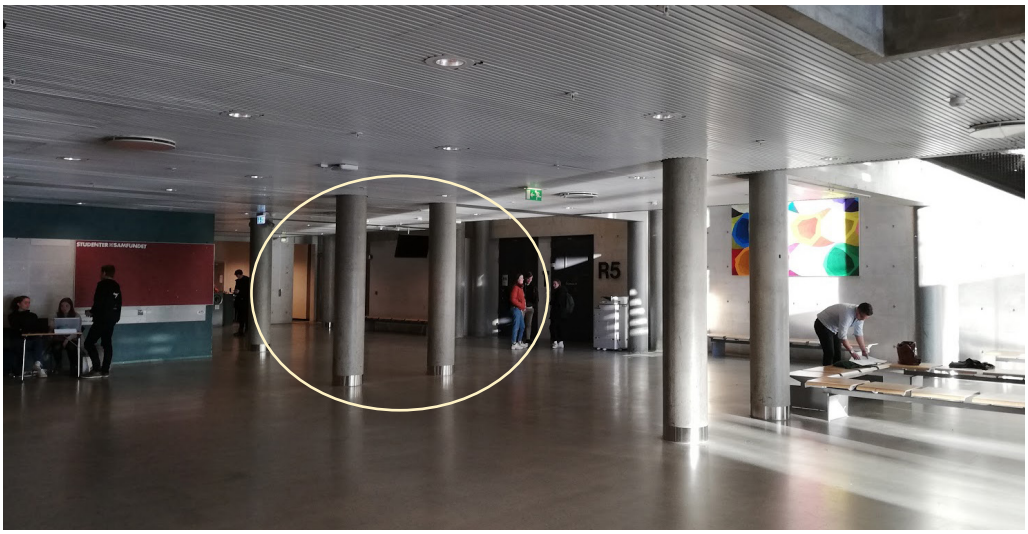


Figure 5.6. Open meeting area at NTNU Gløshaugen. The columns in question are circled.

An open meeting area at NTNU Gløshaugen had a number of concrete columns in the middle of the room. The area is shown in Figure 5.6. There was plenty of space around the pillars so that physical expression would not be limited by the surroundings, or get in the way of other people. The area was observed during a break between lectures, which showed that the site was used mainly as a passage between other areas and for social relaxation. There were some benches along the wall, but these were placed in a rather unsociable arrangement. This left a potential for social expression and play during breaks. A behavioural mapping of people's maneuvering around the relevant columns, or more importantly in the space between them, was conducted to ensure that the installation would not interfere with normal traffic in the area (Figure 5.7). The site was considered appropriate for this type of installation, which accordingly was designed specifically to be mounted to the existing columns in the room. The choice of location should also offer a suitable amount of user test participants.

Figure 5.7. Traffic mapping of installation area.

High Fidelity Prototype

After processing the feedback from the first iteration and detailing sketches from the ideation phase, work on a higher fidelity prototype was started. This prototype was more elaborate both in terms of materials and code. To ensure a robust prototype for testing, more time was spent working on this prototype than the previous. Parts of this prototype, e.g. the poles ended up as part of the final prototype.

Prototype Elements

The poles were constructed using birch plywood for the frame. Aluminium plates for the poles' front faces were cut with a water jet at the Napic workshop at NTNU to create precise edges to fit into the frame and to hold the buttons (Figure 5.8). The number of poles were increased from two to four, and dimensions were increased to 1380 x 240 x 90 mm (Figure 5.9). This became the final visual look of the poles.

Figure 5.8. Game poles with aluminium face and wooden frame, with assembled button.

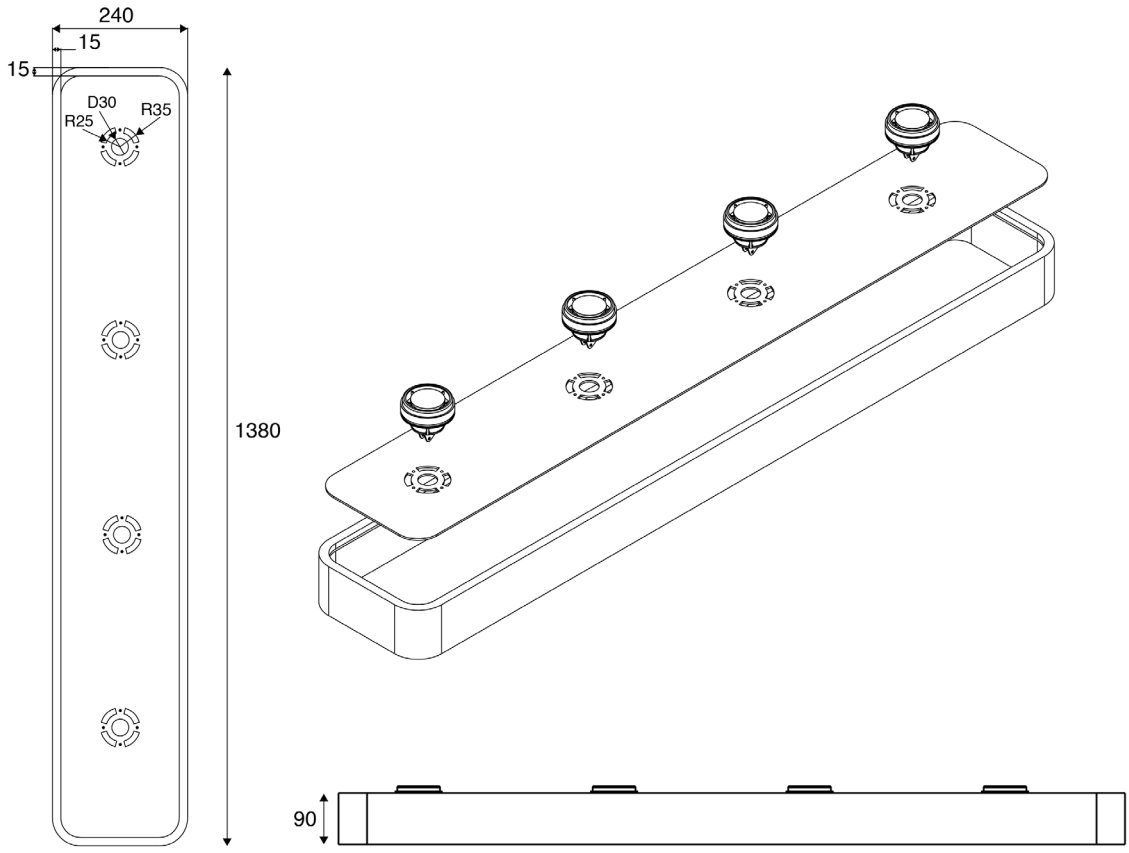


Figure 5.9. Technical drawings of game poles, final version.

The buttons were 3D-modeled in SolidWorks and 3D-printed in black and white PLA using the Prusa i3 MK3S. The LED-rings were integrated inside the buttons, protected by an acrylic cover. These were done in two iterations, the first using threading as the fixing method and the second using screws and nuts (Figure 5.10). The second version worked well, gave a satisfying click when pressed, used less material and required shorter printing time than the first. Technical drawing of the final button is shown in Figure 5.11. In addition to the LED-ring in the front, a steel spring and a microswitch (Figure 5.12) were mounted in the back.

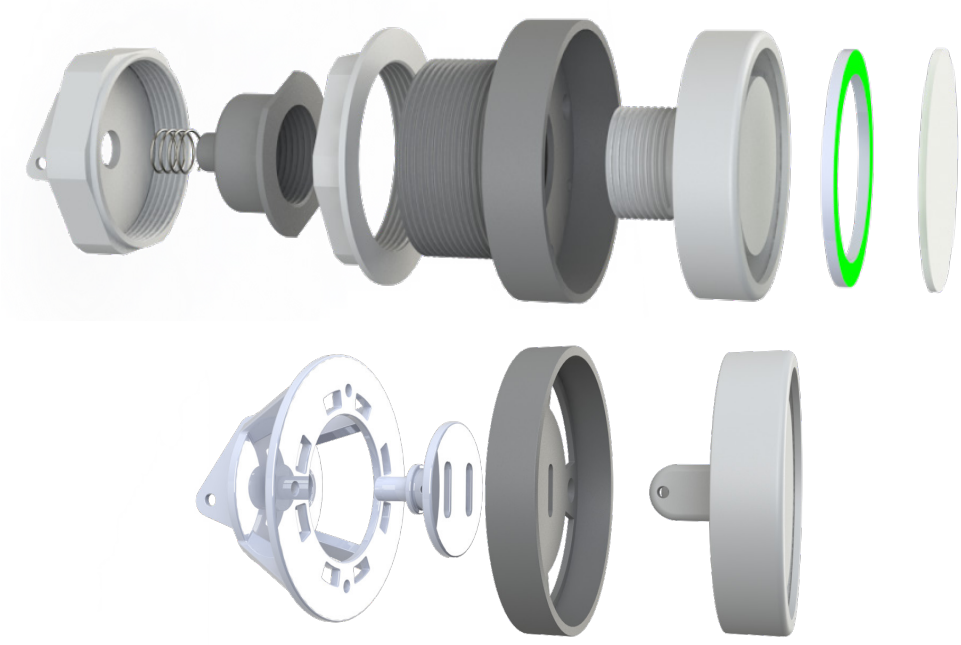


Figure 5.10. First (top) and final (bottom) iteration of buttons.

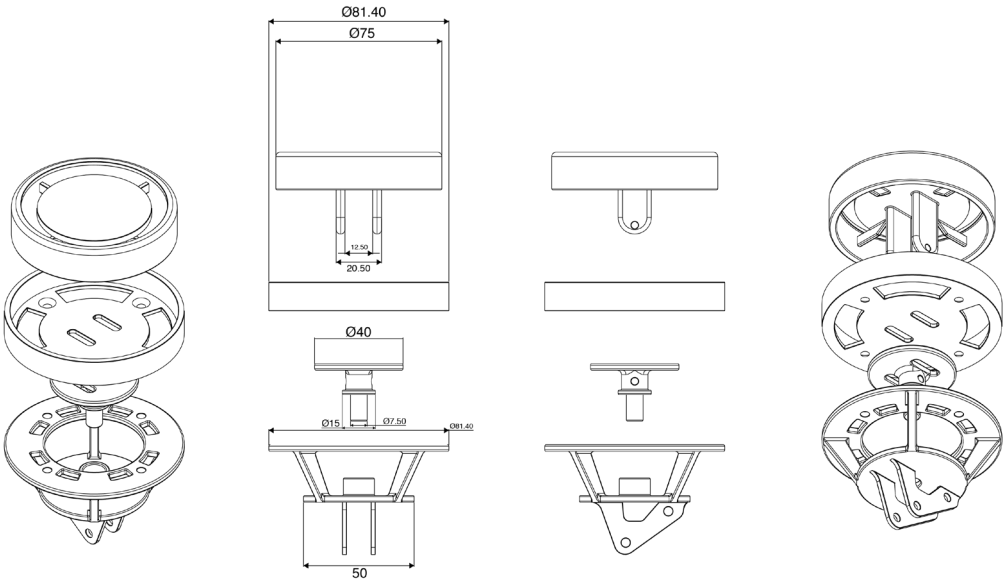


Figure 5.11. Technical drawings of button.

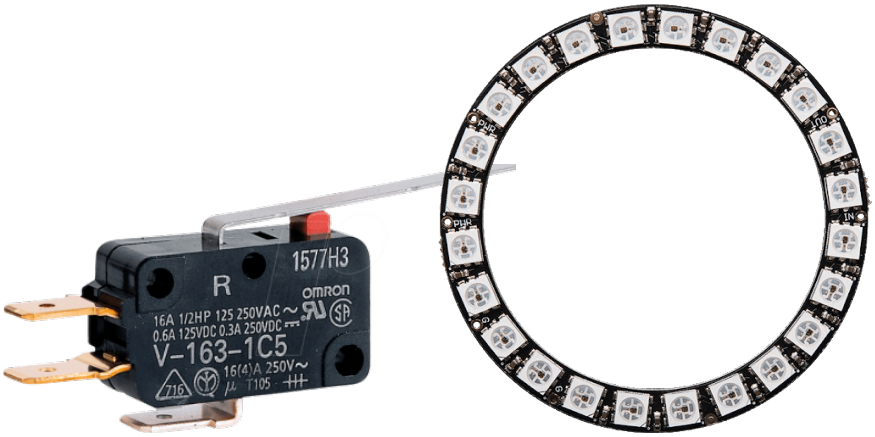


Figure 5.12. Microswitch and LED ring used in buttons.

The LEDs were configured in several ways (Figure 5.13):

- Green pulsing: Is pressed to start the game
- Green countdown, fading to orange: Must be pressed before time runs out to be rewarded a point, or else life is lost
- Red: Should not be pressed, or else points are lost
- Rainbow: Number of active buttons are increased, lives and points cannot be lost (One-player mode only)
- Blue: Freeze mode. Game slows down and the amount of time given to press buttons increases (One-player mode only)

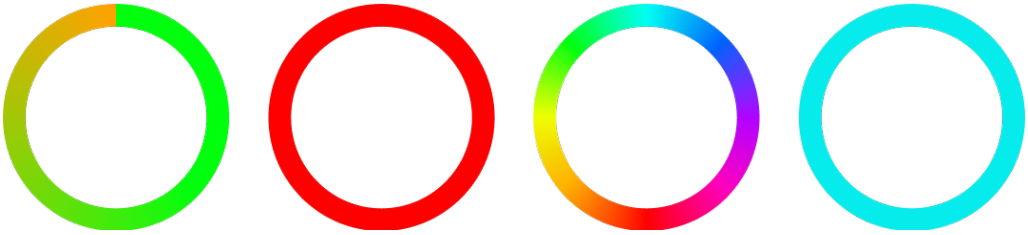


Figure 5.13. Button modes.

The game modes were further developed, including a one-player mode, a two-player competitive mode and a two-player collaborative mode.

- One-player (Figure 5.14): Player disposes of two poles. Buttons light up in various colors. Player goal is to collect as many points as possible until three lives are lost.
- Two-player competitive: Players disposes of two poles each (four in total). Players are given the same lit buttons. Points are given to the first player to press green buttons. The game session consists of three sets, where each set is won at nine points.
- Two-player collaborative: Same configuration as one-player mode, except two players collaborate playing on four poles.

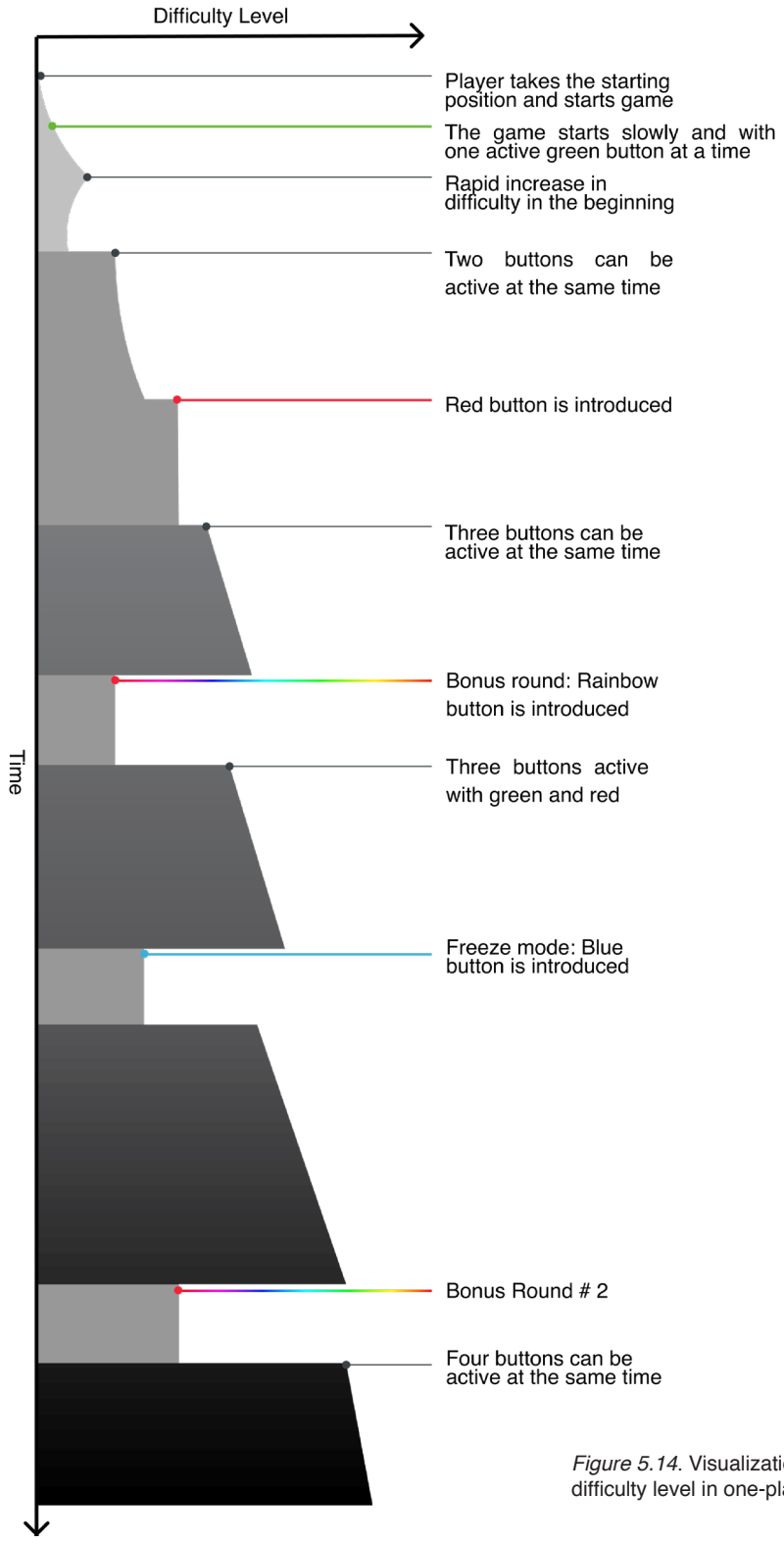


Figure 5.14. Visualization of increasing difficulty level in one-player mode.

A scoreboard was created to meet user feedback. This was configured for all game modes, using three Seven segments to display two-player competitive score e.g. 4-7 or used as a counter for the other modes (range 0-999). The scoreboard also included three LED diodes to symbolize both the three sets of the competitive mode and the three lives in the other modes. Because of its construction, the score was only visible from one side (Figure 5.15). In the selected area of use, this would only let one player see the score at a time. For usability testing, with a different installation setup, this was satisfactory, but was redone to accommodate two-sided viewing later in the process (Iteration 4).

Figure 5.15. Scoreboard during two-player competitive mode user testing.


0 - 9

Usability Test

The new prototype was tested by approximately 20 students from different study programs. They could choose which game mode they wanted to play, but we ensured that all modes were tested. The test was conducted at the Design Department, with the poles leaning against a wall, on top of a bench (Figure 5.16), as a proper method for mounting the poles in the selected area at Realfagsbygget was not yet in place.

The test was conducted to:

- Validate game modes. Which should be further developed?
- Investigate the user interaction
- Test new button colors
- Test score board functionality
- Receive general user feedback

Evaluation and Feedback

The new prototype created a more realistic game experience and the test participants were enthusiastic about the concept. Their opinion about the game modes were divided, but the majority were excited about the competitive mode, as they considered the collaborative mode not challenging enough. Based on the user feedback we saw the one-player and two-player competitive modes as most successful, yet we continued work on all modes. A summary of the feedback is found in Table 5.2.

Tabel 5.2. Summary of feedback from usability test.

Element	Feedback/Suggestions
Buttons	Easy to understand when a button was pressed due to the immediate shutdown of the lights. The pulsing start button was tempting to press.
Poles	The height of the poles was difficult to evaluate, due to the test location and setup. Some very tall test subjects thought they might be a bit too low. Average tall testers though the height was alright.
One-player mode	Freeze mode was highlighted as confusing and unnecessary. Rainbow mode was considered fun, visually and gave the players a kick, but added little to the gaming experience. The scoreboard received good feedback. The players valued being able to track their own score.
Two-player competitive mode	Players were enthusiastic about this mode, and many wanted to play multiple rounds. This game mode was recommended to others by players who had tried it.
Two-player collaborative mode	The test setup provided too short distance between the poles, making this mode too little challenging for the players. Very few were enthusiastic about this mode.

Figure 5.16. Usability test on makeshift setup.

5.4 Iteration 3: Improving the Usability

Implementing Auditory Feedback

The third iteration included introducing the sound system. Sound effects were used for additional feedback on the events of game start and button presses (Table 5.3). The sound effects were chosen based on suggestions from Christer at Studio Gauntlet and the research team members' personal preferences. They were tested and approved by users.

Table 5.3. Sound descriptions

Trigger	Description	Visual effect	One-player mode	Two-player competitive mode
Start-button press	Three short beeps in a lower pitch followed by one longer beep in a higher pitch	All LED rings flashing in green from top to bottom of poles		
Green button press	A short medium pitch click	Green light shutting off		
Red button press	A short low pitch buzz	Red light shutting off		
Game over	Four short beeps, in descending pitch	LED rings flashing in red from top to bottom of poles		
Set over	One short beep followed by a longer beep in the same pitch. Simulating the word "ta-da"	LED rings light up to indicate which player has won the set		

Figure 5.18. Usability test on site.

Minor Technical Improvements

Other smaller improvements and changes were made to enhance usability and user experience. At this point the issues related to the installation had decreased drastically so that more time could be spent fine tuning the variables in the code to e.g. adjust the difficulty level and the amount of points per button press.

When we were transporting the installation to the selected location, we discovered a major drawback of the design: The installation was very tricky to move over larger distances. The columns could not be disconnected from the scoreboard, so the entire installation had to be moved in one maneuver. The wires between the scoreboard and the poles were also too short, and ended up in mid air, very exposed to potential damage (Figure 5.17). The scoreboard construction was also so wide that it was difficult to get through ordinary doors. This was rectified in the fourth and last iteration along with the two-sided score visibility. The mounting system for the existing columns at Realfagsbygget was tested and worked well.

The third iteration prototype was tested with the two two-player modes on site at U1 at Realfagsbygget by passing students and our supervisors (Figure 5.18).

Evaluation

The improvements proved to be a success. After this test, the decision to discontinue the collaborative mode was made. Players expressed a much greater enthusiasm and excitement for the competitive mode. The one-player mode and two-player competitive mode were kept for further detailing. A summary of the user feedback is found in Table 5.4.

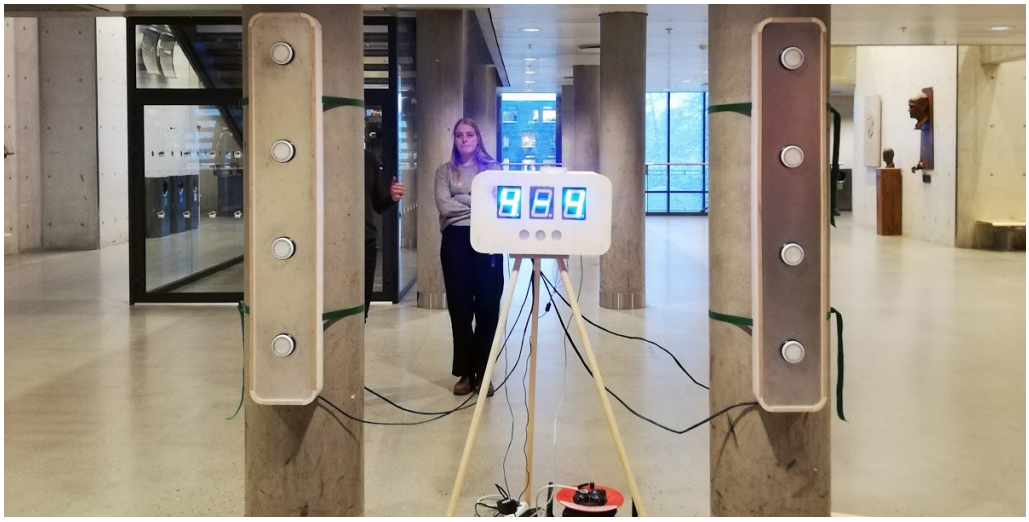


Figure 5.17. Usability test on site.

Table 5.4. Summary of feedback from user test on site.

Element	Feedback/Suggestions
Scoreboard	Players tracked their score throughout the game, highlighting it as a useful feature. The single direction scoreboard was highlighted as a bit annoying.
Poles	The placement of the poles allowed for larger movements, including jumps and squats, making the activity more physically demanding.
Two-player competitive mode	Players wanted a sound effect to signalize when a set is over.
Two-player collaborative mode	The game mode was still not considered challenging enough. Players stated that they more easily entered a competitive mindset than a collaborative one.

5.5 Iteration 4: Final Preparation and Optimizing for Use

The fourth and final iteration mainly included building a new, two-sided scoreboard with better configuration for both game modes (Figure 5.19). The new scoreboard also facilitated tidy wiring, thus less time consuming troubleshooting. The Arduinos and sound system was securely stored inside the bottom box or *hub*, with wiring for the Seven Segments and life lights through the metal pipes. Input outlets were mounted on each side of the bottom box, so that each game pole could be connected and disconnected easily, and therefore able to be moved one by one.

The code was further fine tuned to ensure functioning sound throughout the game loop, and the speed of the game was increased even more to shorten the game duration and encourage bodily movement. The freeze and rainbow modes, which initially were introduced to extend playing time and lower intensity, were removed as they appeared more confusing than amusing to players. When an increased intensity and shorter duration of the game was desired, they were not only unnecessary, but interfering with the project goals.

Figure 5.19. Scoreboard layout for one-player (left) and two-player (right) mode.

Evaluation

By removing two button modes, the user experience was remarkably improved. The game became less complex and easier to understand. This gave players less elements to focus on, so that their mental capacity could be spent developing tactics and testing different movement patterns. The portability of the installation parts, due to the possibility to disconnect the poles from the scoreboard, made it much easier for us to move and handle. The level of errors had decreased drastically, and the prototype was considered satisfactory.


0 0

Chapter 6
Deliver

By iteratively improving and defining the prototype, the scope is narrowed until the final solution meets the set requirements.

The final prototype is an interactive installation game consisting of a scoreboard and four game poles that can be mounted in any arrangement on existing columns or walls, depending on the chosen site and mounting equipment. The poles' height and distance can be adjusted to allow different levels of physical activity. Each pole has four buttons with integrated RGB LED rings, that can light up in three different modes: Pulsing green, green with gradual countdown to yellow and solid red. The installation includes two game modes: one-player and two-player competitive, using respectively two and four poles. The game accommodates one or two players, but could be adjusted for more players by upping the difficulty level, which can be easily done by changing variables in the Arduino code.

The installation encourages playful, physical activity, by demanding movement both horizontally and vertically. When jumping from side to side, the players' balance is challenged. The rapidity of the game activates the eye-hand coordination, while also requiring a level of mental focus. It promotes active breaks for students and can function as a mental distraction from daily tiresome duties and routines.

6.1 Game Mode Descriptions

Table 6.1 shows an overview of the differences between features of the two game modes.

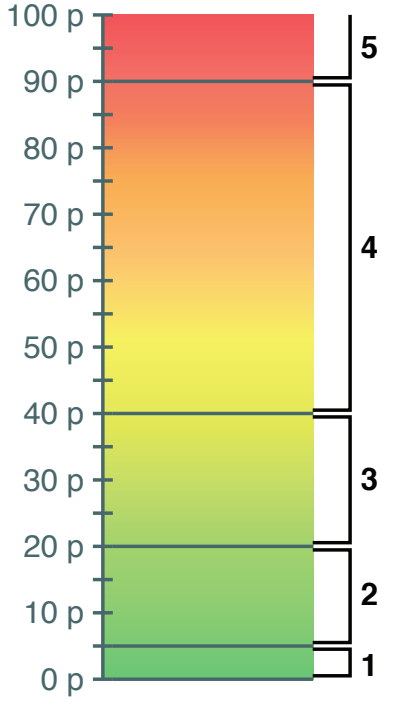
Table 6.1. Game mode overview.

Feature	One-player mode	Two-player mode
Number of poles in use	2	4
Game goal	To reach highest possible score	To win the most out of three sets
Button modes	Green with countdown and solid red	Green with countdown and solid red
Number of levels/sets	5 levels	3 sets
Scoreboard configuration	3 Seven segments on one side	2 Seven segments on both sides

One-player mode

Two poles were placed a desired distance apart (1.5-2 meters was sufficient). The point of the game was to collect as many points as possible by pressing buttons that lit up in green, before the countdown in the LED ring on the button was over. The scoreboard worked as a counter, giving one point per successful button press. Each player was given three lives at the beginning of the game, indicated by three lit (blue) lights on the scoreboard, below the score. If the player failed to press a button before the countdown ended, a life was lost, indicated by one of the life lights being shut off. Red buttons occurred from time to time. If these were pressed, points were deducted. The score was visible during the entire game session, and was not reset until the next game session was started.

The score also had an invisible function in the game; defining the *levels*. These levels were not obvious to the user, but could be noticed by the increased difficulty level. The difficulty was gradually raised with shorter countdowns and more active buttons. The red button was introduced in level 2 with a 10 % probability of occurring. The levels and corresponding variables are shown in Figure 6.1. The maximum score is 999, but to keep the game duration relatively short, the difficulty level was adjusted to peak just below 100 points.



Level:	Active button(s):	Time between button activation (ms):	Countdown time (ms):
5	3	1 500	1 440
4	3	2 000	1 920
3	2	2 000	1 920
2	2	2 500	2 400
1	1	2 500	2 400

Figure 6.1. One-lpayer mode levels.

Two-player mode

Four poles were placed with the same distance apart as the one-player mode, back to back, so that the two players stood face to face, with the scoreboard between them. Final prototype setup is shown in Figures 6.2 and 6.3. Each player used one pair of poles. Each player was given the same combination of green and red buttons, and the first player to press a green button was rewarded a point. Red buttons gave, as in the one-player mode, minus point, unless the score was zero. Each game session consisted of three sets of nine points. The first player to reach nine points won the set. The life lights were used to indicate which player who had won each set. The time between each active button was generally slightly longer than in the one-player mode, but the duration of the countdown was the same and the red button was introduced in the second set, also with a 10 % probability.

Technical Components

The prototype was created using the following hardware components (Table 6.2):

Table 6.2. Technical components.

Qty	Component
2	Arduino MEGA 2560 (Master and slave)
1	Arduino UNO (Slave)
1	Arduino AdaFruit MP3 shield
16	Micro Switch
16	LED rings (e.g. AdaFruit)
2	USB speakers
6	LED RGB diodes
4	Seven Segment displays

One of the Arduino MEGAs, being the master, controlled the main logic, chosen based on previous experience of the project team. This had a sufficient amount of available pins for the buttons and various LED lights, as well as communication with the other (slave) Arduinos. The larger memory, compared to the Arduino Uno allowed for more complex programs (Arduino, 2020). The connections between the components are shown in Figure 6.4.

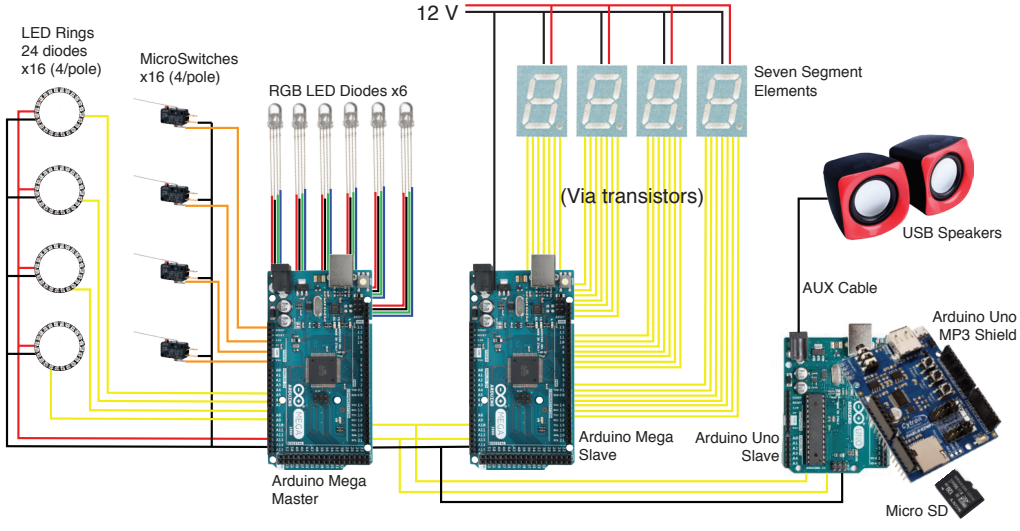


Figure 6.4. Wiring diagram.

Figure 6.2. Final prototype setup.

Figure 6.3. Prototype setup with players.

Part 2: Installation Experience Study

Chapter 7
Data Collection Methods

The following work was done with the purpose of creating a detailed image of students' relations to public installations on campus, and how they experience the installation as a whole. The goal was to gather as much information as possible about the users' experience with the installation prototype, and try to identify their motivations in the game and thresholds for daily use of such an installation. The methods used and their qualities and possible disadvantages are described in this chapter.

7.1 Overt Research

As opposed to covert research, where participants in a research project are unaware of their participation, the test participants in an overt research are fully informed and aware of both their participation and the researcher's presence and objectives. A benefit of this method is that the participants are able to give their consent, thus making the research more ethical. This may also lead to less frustration with the participant, as he or she can ask questions during the research. Also, as an informed participant, one may feel more free in the test situation, due to the communicated opportunity to withdraw from the study at any time.

One may question, however, if the participant is really able to give their consent, or more importantly disconsent in such a situation. Participants may feel that they are wasting the researchers' time if he or she refuses to consent to their plans. Students do, to some extent, respect the work and time of other students, and may, by conscience, accept terms they do not really agree with, in fear of appearing unreasonable or difficult. In this project, it was likely that friends or acquaintances of members of the research team could show up as participants. In these cases it was necessary that the research team was prepared to switch roles, to avoid participant bias.

Another important possible disadvantage of overt research method is the 'Hawthorne Effect' (Oates, 2006), which means that research participants will modify their behaviour when they know they are being observed. Upsetness or frustration may also occur for the participant if they are feeling judged on their behaviour. At the same time, they also have to figure out how to address the researcher – should they ignore them or be polite? Getting used to the test situation may take some time, and the aspects above were considered carefully when planning the user test.

7.2 Recruiting Participants

In an anticipated, natural use situation, users will not be invited to use the installation, except maybe by friends, and the installation will not be serviced in any way. The test participants would therefore have to seek out or discover the installation themselves. To boost the happening of the test, and to create some buzz in the area of the installation, we invited some friends to start off the test sessions as “fake participants”. Posters communicating that we needed test participants, and the opportunity to win cinema gift cards, were hung up in the installation area. The happening of the test phase was promoted on the project team members’ personal social media, such as Instagram and Facebook.

7.3 Test Setup

The test session was designed to gather data in four different ways: (a) data logging from the Arduino microcontroller, (b) observing users’ interaction with-installation, (c) interview of test participants and (d) a user questionnaire. The test setup was accordingly arranged in four stages: (1) introduction, (2) installation test, (3) interview and (4) questionnaire. The stages are illustrated in Figure 7.1. This triangulation created a convergence of multiple methods on the research question to justify and validate the evidence from several angles. By combining sources of data we could ensure accuracy of the gathered information and increase confidence in the results.

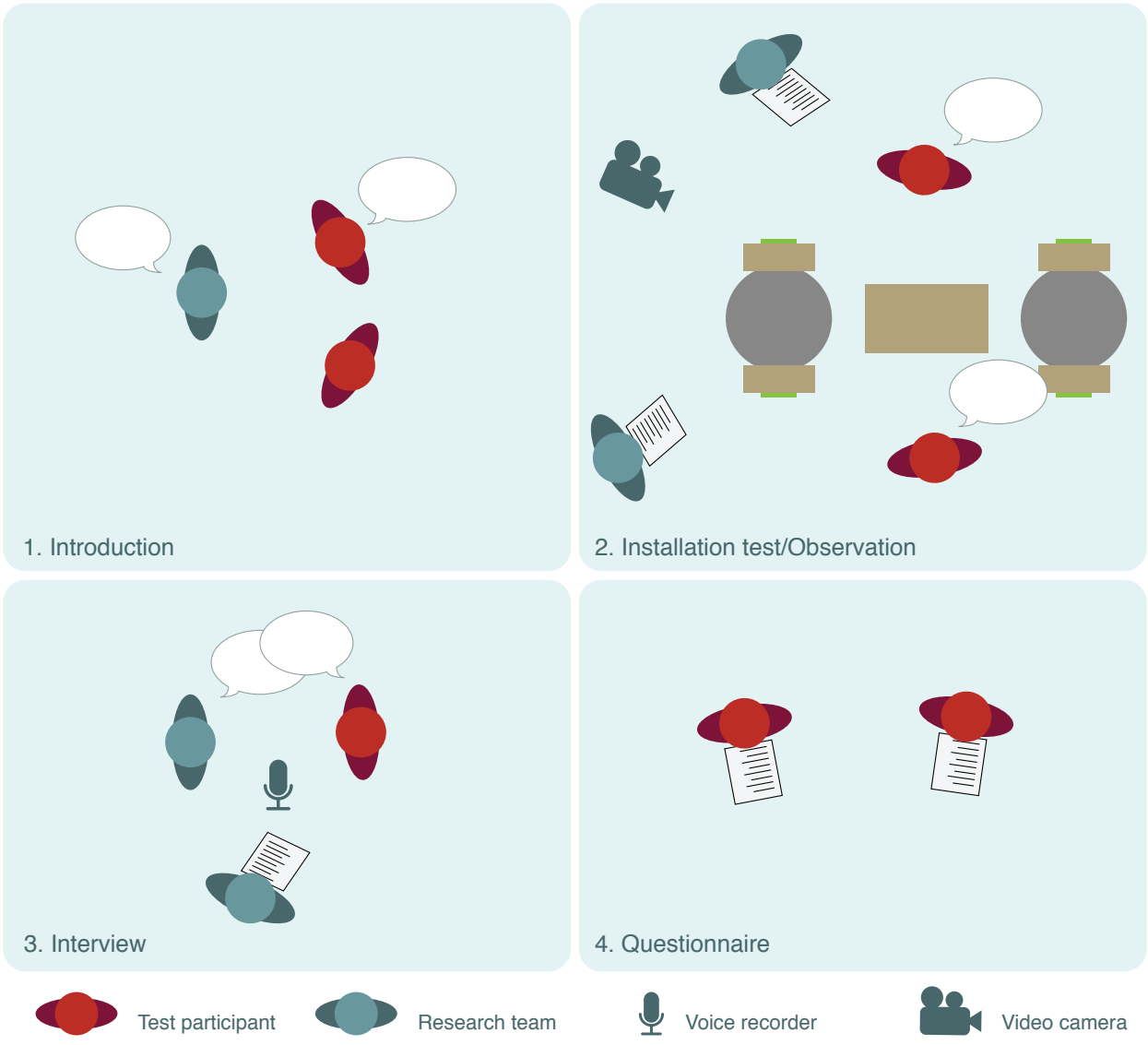


Figure 7.1. Illustration of user test session stages.

Participant Introduction

Test participants were provided as little input as possible about the installation itself from the project team during the session to simulate a natural use situation. The participants were therefore exposed to the installation after only a short introduction to its functionality and features. This was done to observe how the participants would interact with the installation outside the test situation, thus making the circumstances more realistic. In an actual encounter with the installation, the user would not get a thorough explanation, except potentially from people who have used the installation themselves, or by observing other users. The lack of explanation would also test if the main functionality is clearly communicated by the installation itself. In order to maintain an overt research and follow ethical guidelines, all participants signed a consent form (Appendix B).

Observation

While using the installation, the participants were knowingly and with consent observed by at least two members of the research group. Their behaviour in the game situation was carefully noticed and the occurrence of certain predefined events were registered in a form (Appendix C). At the same time, the observers had a broad focus throughout the observation session, to detect major behavioral deviations. The observation session was included in the test programme to detect what the users actually do, not only what they say they do when questioned. To ensure no important information was lost due to distraction or loss in concentration of the research team, and to assist the subsequent analysis, the test session was, by participant consent, video recorded.

Arduino Data Logging

While participants explored and tried the installation, the Arduino microcontroller inside the installation logged certain predefined effects of the users' manipulations of the installation. The log included the parameters listed below:

- Session number
- Timestamp for game start
- Game duration
- Average response time
- Shortest response time
- Longest response time
- Number of green buttons pushed
- Number of red buttons pushed
- Specific for single-player mode: Timestamp and button for life-loss, score
- Specific for two-player competitive mode: Score for each set

These registrations have supported the data analysis by substantiating our observations. It was a low cost option as it did not require monitoring of the research team during the data collection.

Interview

Due to the project schedule, with limited time for transcription and analysis, only a selection of the participants were interviewed. In the test planning a target goal of 20-25 interviews was set. This amount of input, combined with data from other methods, should sufficiently shed light on the most important trends in the response. To ensure heterogeneity in the respondent group and to avoid having only the most eager and enthusiastic participants as interviewees, the interview participants were randomly selected before having played the game.

The interview was conducted after the observation. It was semi-structured in order to let the participant further elaborate on desired themes. This contributed to a qualitative data basis for the analysis. In order for the participants to express their honest opinions, it was important that the questions were formulated so that they did not put words in the mouth of the respondent. This was done by phrasing the questions in an open manner, like “How did you feel during the game?” rather than “Did you feel good during the game?”. The interview was conducted in Norwegian, and the full interview guide can be found in Appendix D.

Questionnaire

The questionnaire was filled out by all participants after the game session or the interview. The questionnaire had two sections. The first was a list of nine statements where the participants should tick whether they completely agree, somewhat agree, neither nor, somewhat agree or completely agree. By doing this, the data collected from each questionnaire was automatically in the same format and therefore easily analysable by making major trends more obvious than with free text answers. The second part of the questionnaire was introduced with the question “to what extent did the following aspects contribute to your enjoyment in the game?” followed by eight aspects. Each of these should be graded by ticking “not at all”, “a bit”, “some”, “a lot” or “very much”. The questionnaire was given in Norwegian, and can be found in Appendix E.

Chapter 8
Analysis Methods

8.1 Observation and Video Analysis

Analysis

The registrations from the observation sessions were plotted into a form. Field observation only let us notice the most remarkable events during test sessions, so these forms were primarily used to remember them. Heath & Hindmarsh (2002) state that it is impossible to recover the details of talk through observation alone, and "if it is relevant to consider how people orient bodily, point to objects, grasp artefacts and in other ways articulate an action or produce an activity" it is unlikely that one is able to grasp more than a passing understanding of the situation. However, the video analysis can provide these valuable details. To capture proof of events, statements and interactions, the video material was analyzed by rewatching all game sessions and taking screenshots of interesting situations, before adding a description of the relevant situation to each image (Example in Figure 8.1). Some events were captured by screenshotting several moments from a segment of the video, to show a course of conduct through a storyline. The detailed analysis of the video material let us observe the user-installation interaction and the social interaction with other players and audience, without the distraction of other people or disturbances in the installation area.

	Player doing boxing moves before game start.
	Player jumping for green button but withdraws because the button is gradually turning yellow.
	A bug in the installation causes some diodes in the LED ring to light up when they should not. The player is distracted by these even though he is told not to. Causes him to miss other buttons.
	Winning player asking the research team: "What? Did I win?"

Figure 8.1. Example of screenshots from video material with description.

8.2 Arduino Data Logging Analysis

Almost every game session throughout the data collection phase was logged, even when the research team was debugging the installation. This created some errors in the data, which needed a data cleansing before the analysis could be conducted. The data from the two different game modes were treated differently in order to find data variances for the game modes. The complete data set was used when aspects that were relevant for both modes were calculated. Figure 8.2 shows an example of how the unprocessed logged data looked.

```
Session: 1, started 23010
Time: 75595
Score: [0-9,0-9,0-9]
Winner: [2,2,2]
Avg P1: 0
Fastest P1: 100000, button: 20
Slowest P1: 0, button: 20
Avg P2: 1184
Fastest P2: 688, button: 10
Slowest P2: 1763, button: 15
Red buttons pressed0
Red time: []
----------------------------------------
Session: 2, started 108596
Time: 78911
Score: [9-0,9-0,9-0]
Winner: [1,1,1]
Avg P1: 1296
Fastest P1: 682, button: 5
Slowest P1: 2087, button: 0
Avg P2: 0
Fastest P2: 1000000, button: 10
Slowest P2: 0, button: 20
Red buttons pressed2
Red time: [45599,57770]
----------------------------------------
```

Figure 8.2. Example of Arduino log data.

8.3 Interview Analysis

During the data collection phase, 20 interviews were conducted, 10 from each game mode. The material from the interviews was processed following these steps: a) Transcription of audio files, b) Coding in Nvivo, c) Clustering codes, d) Restructuring and e) Code review and comparison.

Transcription of Audio Files

Interview audio recordings were first transcribed verbatim (Example 1), completely without interpretation, except when adding context-explanatory words in brackets. An example of a complete transcript is found in Appendix F. Every question from the interviewer was marked with an "I" for interviewer, and statements and answers from the participant with a "T" for test subject. Noises and talking from the surroundings were excluded from the transcript. Interview transcripts were saved locally in separate Word files.

Example 1: Verbatim Interview Transcript

> I: Was there anything particular that you enjoyed about the game? Any specific elements that stood out positively?
>
> T: I thought it was good that there was a timer on the button, because it helped uhm… And then it was suddenly: "Oh, shit, I'm about to… it's about to die" kind of, so then I have to be quicker with this one than that one. It varied in time, when there were two buttons, could it vary in time?
>
> I: If there are two at the same time, they kind of have the same, but they last shorter and shorter throughout the game.
>
> T: Yeah, true. And the distance on them [poles] has a lot to say. Because if they were closer it would have been easier to see, but they're just far enough apart to make it hard to see. So it was challenging, actually.[1]

Coding in NVivo

All transcript files were imported to NVivo 12 for qualitative data analysis. Themes or 'codes' were consecutively created based on the participants' responses. Descriptive coding, where the codes summarize the primary topic of any encoded statement (Saldana, 2009), was chosen as the method for the analysis. This allowed us to sort the statements based on the participants' actual responses. Example 2 shows how a statement typically was encoded.

Example 2:

Example statement from transcript:	Code:
“I don't know if that [audience] would matter too much, because when I first start playing, then I'm in it anyway.”	Audience

Clustering

When creating a new code for a statement, this was automatically assigned the highest rank as a top level node. Many codes were very similar, and could be merged, and most codes were subtopics of more general topics, e.g. “Audience” and “Strangers” are both subtopics of “Social Surroundings”. To organize the coding further, the nodes were clustered thematically, as shown in Figure 8.3. Statements could also be coded in multiple nodes, as shown in Example 3.

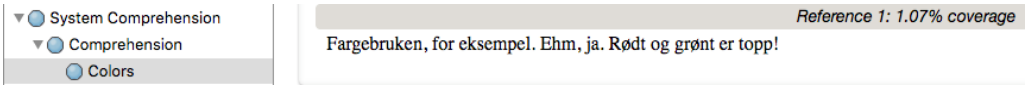


Figure 8.3. Example of code clustering.

Example 3:

Example statement from transcript:	Coded at top level node:	Coded at child node:
“I don't know if that [audience] would matter too much[1], because when I first start playing, then I'm in it anyway.[2]”	[1]Social Surroundings	Audience
	[2]Motivation	Mental Focus

Restructuring

The coding process was iterative, and changes were applied frequently. This included both rearranging and restructuring the nodes and adjusting the coding of statements. This was done numerous times until a satisfyingly orderly system was achieved. Figure 8.4 shows the final top level structure.

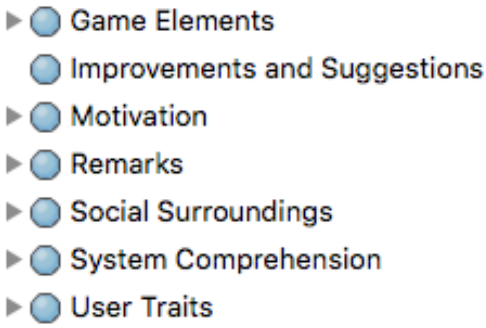


Figure 8.4. Final top level structure.

Code Review and Comparison

Within the research team, two different sets of coding was conducted to avoid researcher bias. Due to lack of comparison functionality in the software, the sets were compared manually. After thorough discussion and applied changes, one set was agreed upon.

Quotation in Thesis

In order to give the reader a better reading experience, some of the quotes from the interviews were somewhat simplified. This mainly included removing fill words like “kind of” and “like” where these were redundant, and not least sounds like “eh” and “uh”. Although these words and sounds help to emphasize how the interview subjects express themselves, I have ensured that the essence of the statements is preserved. Effort was also made to preserve the correct meaning of the statements when translating from Norwegian to English. When quotations in this thesis included both interviewer and test participant statements, these were marked respectively with “I” or “T”. All other quotes, without marking, were made by participants. All statements are marked with a note, referencing the Norwegian versions which are found in Appendix G.

8.4 Questionnaire Analysis

The data collected in the questionnaire was analyzed quantitatively. The response forms were plotted into a Google form, to organize the responses easily. The outcome of this was both a set of figures like Figure 8.5, and a spreadsheet (Figure 8.6). Both were used to calculate various distributions and mean values used in the Results chapter.

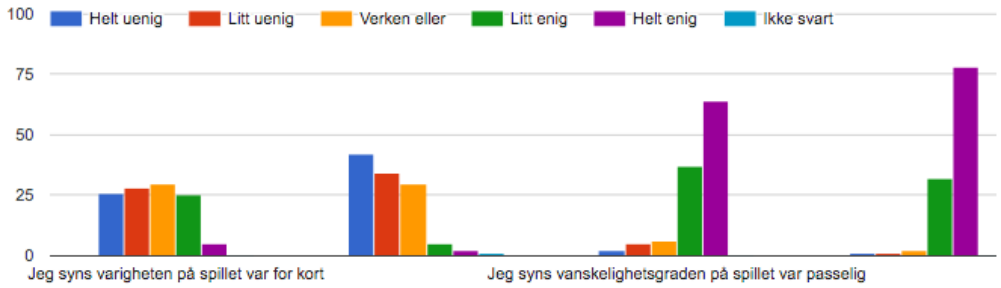


Figure 8.5. Example figure from Google Forms.

19	Litt uenig	Helt uenig	Litt enig	Litt enig	Helt enig	Verken eller	Litt eni
24	Litt enig	Helt uenig	Litt enig	Litt enig	Helt enig	Helt uenig	Helt er
22	Litt enig	Helt uenig	Helt enig	Litt enig	Helt enig	Verken eller	Helt er
23	Litt enig	Helt uenig	Helt enig	Litt enig	Helt enig	Verken eller	Litt eni
21	Verken eller	Helt uenig	Litt enig	Helt enig	Helt enig	Helt uenig	Helt er
22	Verken eller	Helt uenig	Litt enig	Helt enig	Helt enig	Litt uenig	Verken
22	Helt uenig	Helt uenig	Helt enig	Helt enig	Litt enig	Litt uenig	Litt eni
22	Helt uenig	Helt uenig	Helt enig	Litt enig	Helt enig	Helt uenig	Helt er
20	Litt uenig	Helt uenig	Helt enig	Litt enig	Helt enig	Helt enig	Verken
22	Helt uenig	Helt uenig	Helt enig	Helt enig	Helt enig	Helt enig	Litt eni
22	Litt uenig	Helt uenig	Helt enig	Litt enig	Helt enig	Litt enig	Helt er
21	Helt uenig	Helt uenig	Helt enig	Helt enig	Helt enig	Verken eller	Litt eni
19	Litt uenig	Helt uenig	Litt enig	Helt enig	Litt enig	Verken eller	Litt eni
22	Helt uenig	Helt uenig	Litt enig	Litt enig	Helt enig	Litt uenig	Helt er
22	Helt uenig	Helt uenig	Helt enig	Verken eller	Helt enig	Verken eller	Litt eni
22	Helt uenig	Helt uenig	Helt enig	Helt enig	Helt enig	Litt uenig	Helt er
20	Litt uenig	Helt uenig	Helt enig	Helt enig	Helt enig	Helt uenig	Helt er
21	Litt uenig	Helt uenig	Litt enig	Litt enig	Helt enig	Verken eller	Helt er
23	Helt uenig	Helt uenig	Helt enig	Helt enig	Helt enig	Litt enig	Helt er
22	Helt enig	Helt uenig	Litt enig	Helt enig	Helt enig	Verken eller	Helt er
23	Litt uenig	Helt uenig	Helt enig	Helt enig	Helt enig	Helt uenig	Helt er
21	Verken eller	Helt uenig	Helt enig	Helt enig	Helt enig	Verken eller	Helt er
20	Helt uenig	Helt uenig	Helt enig	Helt enig	Helt enig	Verken eller	Verken
20	Litt uenig	Helt uenig	Helt enig	Helt enig	Helt enig	Litt uenig	Helt er

Figure 8.6. Excerpt of spreadsheet generated by Google Forms.

Distributions

Based on the number of test participants ticking off the different alternatives, a distribution was calculated for each question. These distributions show what percentage of the participants that gave what answer. An example of this calculation is shown in Table 8.1. Distributions for all questions are presented in Chapter 9. Analysis of Results.

Table 8.1. Example of distribution calculations.

	Completely disagree	Somewhat disagree	Neither disagree or agree	Somewhat agree	Completely agree	No answer
I found the duration of the game to be too short (Number of answers)	26	28	30	25	5	0
I found the duration of the game to be too short (Percentage)	22,8	24,6	26,3	21,9	4,4	0

Mean Values

To calculate a mean value or average answer for each question, the alternatives were given a value from 1-5: “Completely disagree” = 1 to “Completely agree” = 5, and “Not at all” = 1 to “Very much” = 5. After assigning a value to the alternatives, the number of registered answers for each alternative was counted and multiplied with their respective value. These numbers were then added, and divided by the total number of responses. This gave a value between 1 and 5, e.g. 3.5 which means that the average opinion on that specific question was in the middle of “Some” and “A lot”. This was done separately for the two game modes, thus giving a good overview of the general opinion among the test participants of the two groups. Mean values for all questions are presented in chapter 9. Analysis of Results.

Chapter 9
Analysis of Results

The results of the data collection will be presented chronologically based on their relation to the users' journey through the installation experience. The journey is divided into four stages: 1) Discovery, 2) Audience, 3) Playing and 4) After game. The user perspective has been emphasized throughout the data analysis and the majority of the findings are related to the user.

This study has been partly quantitative and partly qualitative, meaning our results come in many shapes; in numbers, user quotes, distributions, pictures and mere observations made by the project team. Not all matters brought up in this chapter are supported by multiple sources of data.

Implications with the installation that occurred during the data collection phase are presented last in this chapter.

9.1 Overview of General Findings

Before going specifically into the results in relation to the user journey, I present an overview of the general findings, such as a) the target population and sample size of this study, b) interview topics, c) questionnaire distributions and d) questionnaire mean values.

Target Population and Sample Size

The target population or theoretical population for this study was all users of Realfagsbygget at NTNU Gløshaugen. This is to whom we wish to generalize our findings. As predicted, all users of the building are not interested in play and physical activity, thus making the actual study population or accessible population less general. The test was conducted with 114 participants, where 59 of them played the competitive two-player mode, and the other 55 played the single-player mode. All 114 tests were logged by the Arduino data collector and 114 subjects filled out the questionnaire. Due to a high workload on the research team, approximately 4 of the tests were not registered in the observation forms, but observed later from video recordings. 20 of the participants, 10 from each game mode, were interviewed. The average age of the sample, rounded down to whole years, was 22 years. The age distribution is shown in Figure 9.1. The gender distribution was 59.6 % males and 40.4 % females (Figure 9.2). Compared to the gender distribution at campus Gløshaugen which is 63.2 % males and 36.8 % females (Academic Administrative Division, NTNU, 2020, Appendix H), I conclude that the sample, in terms of gender, is representative for the population.

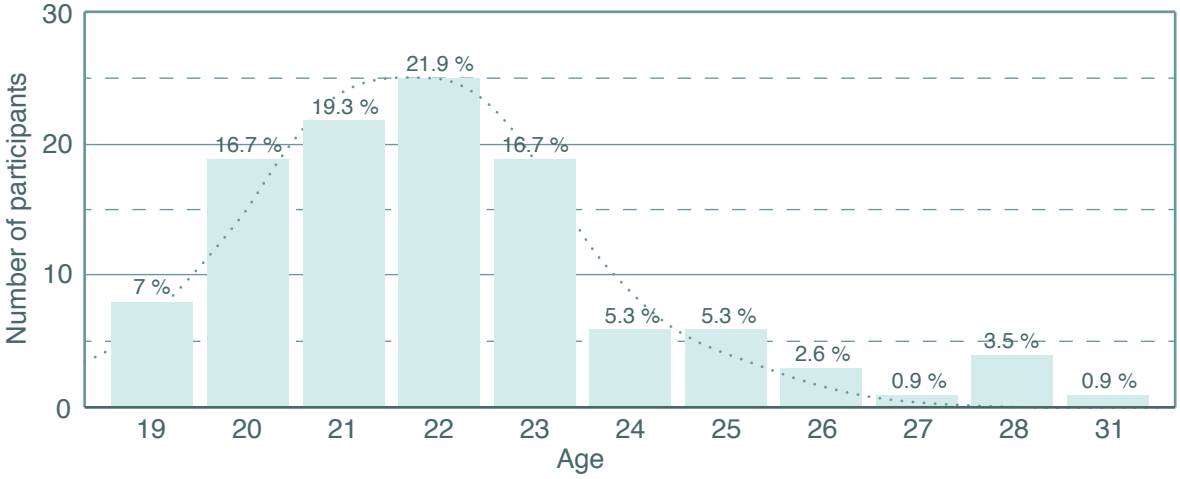


Figure 9.1. Age distribution of questionnaire respondents.

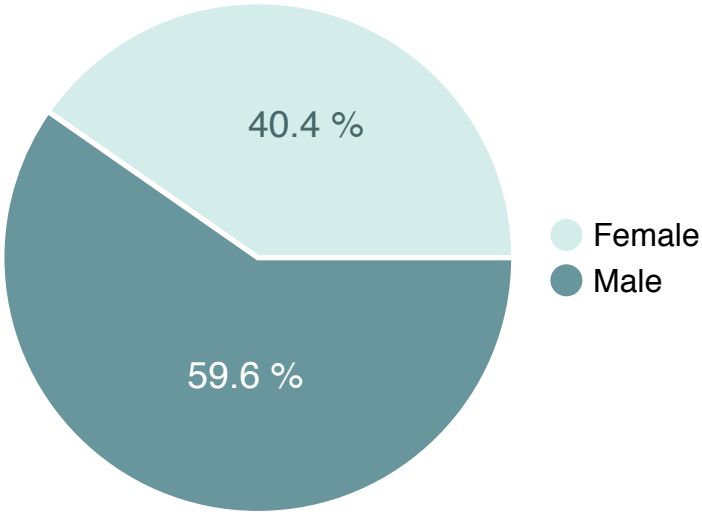


Figure 9.2. Gender distribution of questionnaire respondents.

Interview topics

From the interview analysis conducted in NVivo 12, six themes appeared to be of particular importance. This selection is partly based on the amount of time and words the participants spent talking about them, but as the interview was semi-structured, the interview guide itself suggested a certain distribution in topics, thus making the selection partly based on our pre-interest in particular topics when planning the test session. The six topics are as follows in Table 9.1. All topics and subtopics are visualized in Figure 9.3.

Table 9.1. Interview topics and subtopics with descriptions.

Topic		Subtopics	Description
Motivation	To Engage	Availability	*Placement and popularity of installation*
		Break	*The need of a break from work*
		Competition	*Contest between peers*
		Honeypot	*Being intrigued by other's performance*
		Inviting Design	*Professional looks*
		Novelty or Curiosity	*Intrigued by a new activity*
		Physical Activity	*Enjoyment of bodily movement*
		Social	*Being part of a social activity*
	To Stay in Game	Assertion	*Experiencing a sense of accomplishment*
		Competition	*The desire to win*
		Mental Focus	*Enjoyment of being focused and captivated*
		Physical Activity	*Mastering the need of bodily movement*

User Traits	Experience	*Associations to previous experiences*
	Mood	*Mood before and after game session*
	Physical Activity Level	*User perception of physical activity demand*
	Playfulness	*Evaluation of personal playfulness*
	Use of Time	*How breaks are usually spent*
System Comprehension	Comprehension	*Unproblematic experiences of learning*
	Confusion	*Experiences of unclear system elements*
	Tactics	*User strategies*
Social Surroundings	Audience	*Influence of being watched*
	Collaboration	*Solving tasks with others*
	Community	*Sense of belonging*
	Other Player	*Communication with opponent*
	Strangers	*Playing with unfamiliar people*
	Waiting Time	*Perceptions of having to wait to play*
Game Elements	Lights	*Experience of installation lights*
	Score	*Scoreboard's influence on users*
	Sound	*Experience of installation sounds*
Remarks	Location	*Location's influence on users*
	Negative Remarks	*General comments of discontent*

Figure 9.3. Distribution of topics and subtopics from user interviews. Sectors are colored from light to dark based on the number of references to each topic, where light means fewer references and dark means more references. The inner circle shows the main topics, while the second and third show the subtopics.

Questionnaire Distributions

Below, in Tables 9.2 and 9.3, the results of the questionnaire are presented. They show the percentage of the total participant population that chose which alternative. Figures 9.4 and 9.5 show the average opinion for two-player mode and single player mode participants separately.

Table 9.2. Questionnaire Part 1:
To what extent do you agree to the statements listed below?

#		Completely disagree	Somewhat disagree	Neither disagree or agree	Somewhat agree	Completely agree	No answer
1.1	I found the duration of the game to be too short	22.8	24.6	26.3	21.9	4.4	0
1.2	I found the intensity of the game too high	36.8	29.8	26.3	4.4	1.8	0.9
1.3	I found the level of difficulty suitable	1.8	4.4	5.2	32.5	56.1	0
1.4	I feel like I got to use my body	0.9	0.9	1.8	28.0	68.4	0
1.5	I would categorize this game as play	0.9	1.8	2.6	21.9	71.9	0.9
1.6	The sound effects made the game easier to understand	14.0	15.8	35.1	16.7	12.3	6.1
1.7	The lights made the game easier to understand	1.8	0.9	5.2	18.4	72.8	0.9
1.8	I consider this activity fun	0.9	0	0	15.8	83.3	0
1.9	I would recommend this to friends	0.9	0	5.3	22.8	71.0	0

Table 9.2. Overview of whether participants agreed or disagreed with statements related to their installation experience. Numbers presented in %. The questionnaire did not include the “No answer” alternative, but as some questions were noteworthy frequently not answered, it was necessary to include it in the results.

Table 9.3. Questionnaire Part 2:
To what extent did the factors below contribute to your enjoyment in the game?

#		Not at all	A little	Some	A lot	Very much	No answer
2.1	**Collaboration (if relevant)**	36.8	8.8	7.0	4.4	1.8	41.2
2.2	**Competition**	0	1.8	6.1	28.0	60.5	3.5
2.3	**Sound**	24.6	26.3	24.6	14.0	2.6	7.9
2.4	**Lights**	0	4.4	17.5	41.2	34.2	2.6
2.5	**Body movement**	0	2.6	8.8	50.0	36.8	1.8
2.6	**Intensity**	0.9	2.6	14.9	32.5	47.4	1.8
2.7	**Concentration requirement**	0	0.9	4.4	33.3	59.6	1.8
2.8	**Unordinary activity**	0	4,4	14,9	29,8	49,1	1,8

Table 9.3. Overview of to what extent various factors contributed to participants' enjoyment of the installation. Particularly interesting figures are highlighted in bold. Numbers presented in %. The questionnaire did not include the "No answer" alternative, but as some questions were noteworthy frequently not answered, it was necessary to include it in the results.

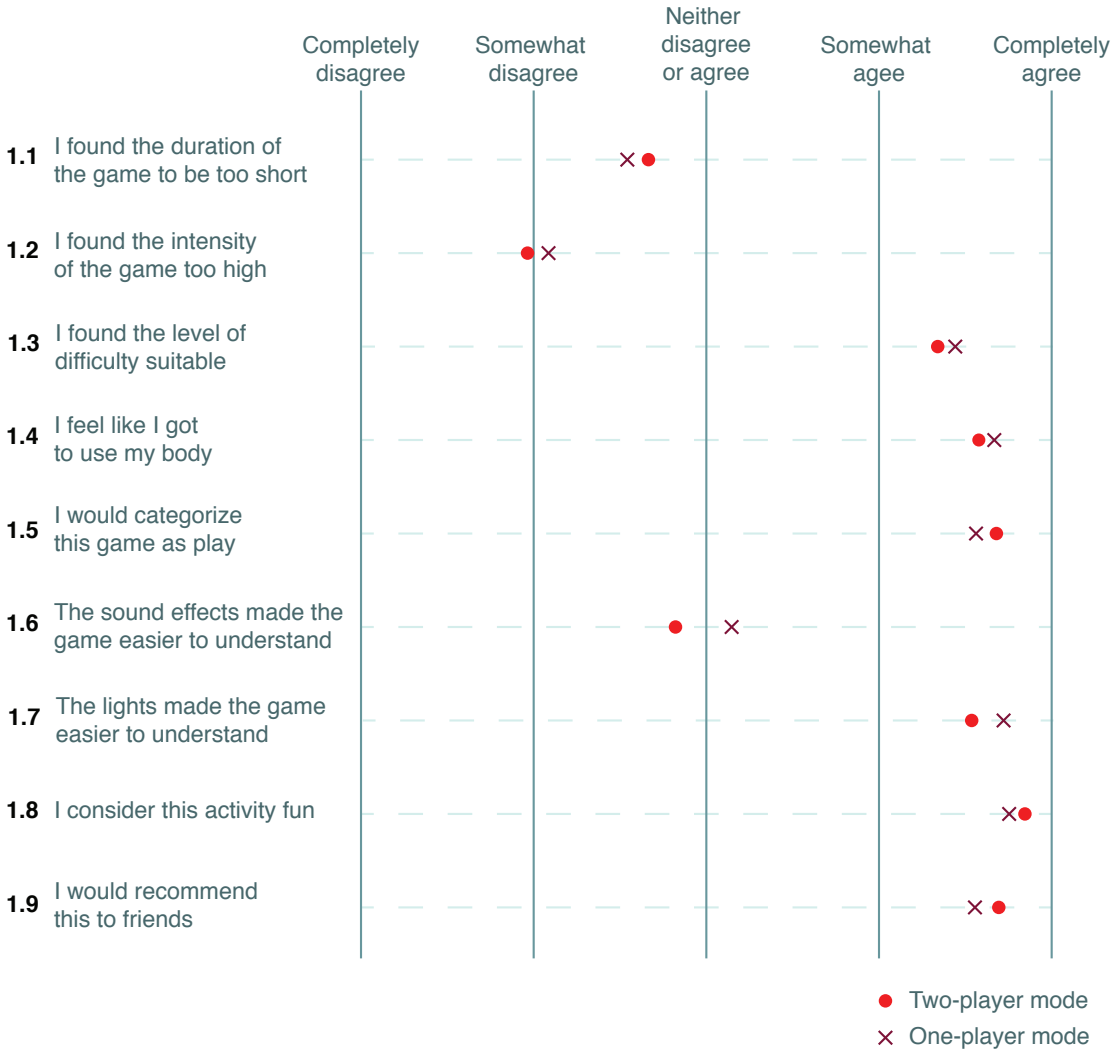


Figure 9.4. Average answers to questionnaire part 1 for two-player mode and single player mode. The two game modes gave quite similar responses, except for question 1.6, where the one-player mode participants had a slightly greater learning benefit of the sound.

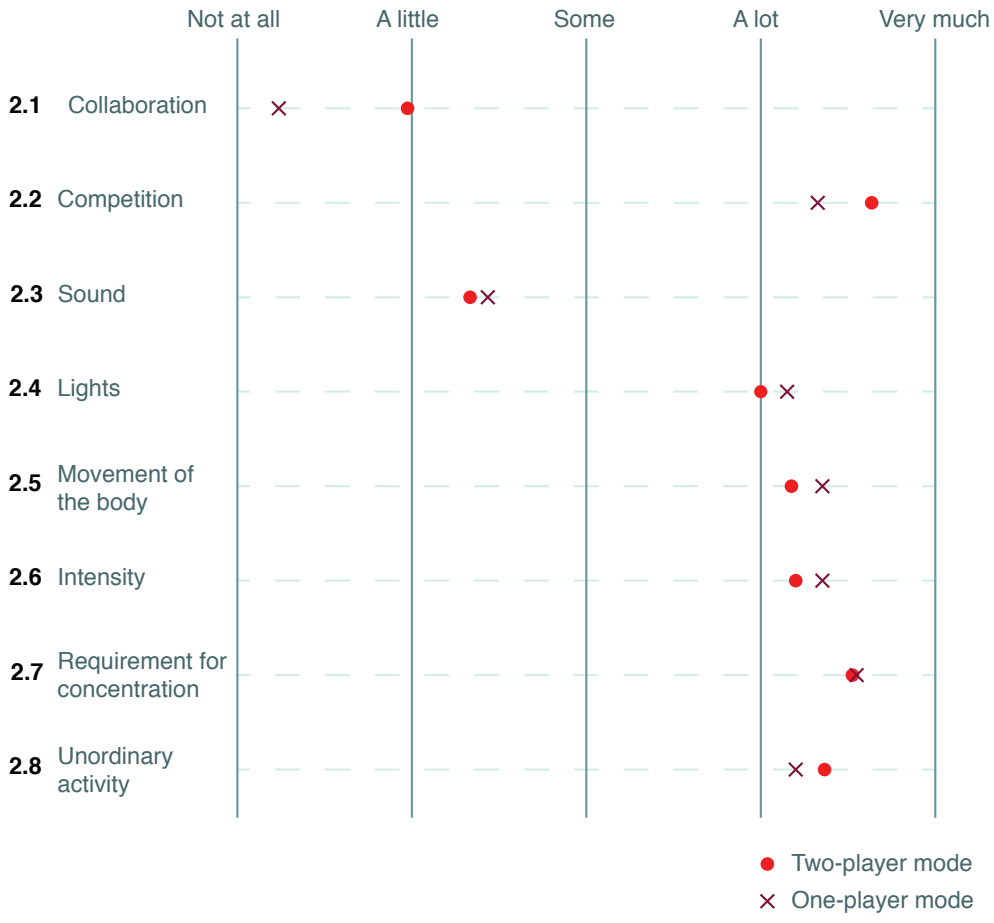


Figure 9.5. Average answers to questionnaire part 2 for two-player mode and single player mode. The two game modes gave quite similar responses, except for questions 2.1 and 2.2, where the one-player mode participants reported the collaboration and the competition as less contributing to their enjoyment of the game.

- Discovery
  - Word of Mouth (WOM)
  - Expectations
  - Location
  - Passer-by Decoding
  - Installation Buzz
- Audience
  - Motivation to Engage
  - Peer Learning
  - Demotivating Factors
- Playing
  - System Comprehension
  - Game Approach
  - Communication
  - In Game Motivation
  - Demotivating Factors
- After Game
  - Sense of Accomplishment
  - Feeling of Break
  - Physical Activity Level
  - Motivation for Repetition
  - Passing on the WOM

9.2 The Discovery Stage

The first stage in the installation experience, holistically speaking, is when the idea of the installation is planted in the user's mind. This can happen through videos on social media, directly from peers or friends, or visually in the installation area. However the method, expectations are made immediately, often based on how the message is presented. As the creator of the installation, there is only so much you can do about *how* your installation is presented and shared by others, but rest assured, if your audience are adolescents or young adults, it will be shared. In this part, findings related to a) how users discovered the installation, b) what their expectations were for the installation, c) how the location of the installation affected potential users and d) evidence of the initial learning or *decoding* process are presented.

Word of Mouth

When new activities or events appear on campus, the most effective promotion for these is through the word of mouth. Students trust their peers, and their opinion is valued, especially if it is positive. From personal experience, I can ensure that nothing breaks up the sense of concentration in a classroom more than when someone, by their own initiative, promotes a fun activity that can distract you from school work. When seeing classmates on social media doing fun things, that is the place you want to be.

Multiple times, through field observation and in the video analysis, we found evidence of people recording the installation in action on their phones (Figure 9.6). This material was likely shared on social media. The project team also shared videos and pictures of the installation on our personal social media, which led to many of our peers participating in the study. One of these said that she was motivated to try it because "you said you were here, then, so I thought it was nice to try it out, so yeah. I mean, I've seen it on Instagram that you've tested it before and .. It looked like fun!"[2] Another interviewee who had just played the game stated that "I had heard that someone else had played it, and it sounded fun,"[3] and that this was her initial motivation to seek out the installation and try it.

Figure 9.6. Bystander video recording game session on her phone.

Word of Mouth
Key Findings:
- Promotion on social media recruits users
- The word of mouth among friends is a valuable method of promotion

Expectations

We asked all interviewees about their first impression of the installation when they first saw it, before having tried it. Many stated that they were curious and just wanted to check it out, because they thought it looked like fun. Two players said that “I didn’t know what to expect, but I had watched people do it a little before,”[4] and “I don't know if it makes much of an impression”[5]. Some players started explaining the rules of the game, possibly because their expectations were related to the functionality of the installation.

Bystanders would often approach the project team and ask what the installation and its purpose was. These questions were frequently followed by wanting to know if some kind of competition was involved.

It is natural to compare new experiences with the memories of previous similar experiences, and one's expectations often come from previous experiences. To investigate what the participants categorized as similar experiences, we asked about their experience with such installations. Quite a few had tried comparable activities, such as games like Whack-a-Mole and various reaction tests or games either from science centers or military service.

> Yes, I have tried something similar. [...] it was lying on the table and there were two [players] against each other and the point was to tap the most [buttons]. It was that kind of reaction game too, then. It was not the same, but something similar.[6]

Expectations
Key findings:
- The activity was expected to be fun
- Expectations were related to installation functionality
- Competition was expected
- Expectations were created by previous experiences

Location

Several authors (e.g. Tang et al. 2008) agree that the surroundings of a public system affects the user experience. Firstly, it somewhat dictates the demographics of potential users. In this case, the chosen location wonderfully provided us with the audience we needed to conduct our study. Secondly, the surroundings, in terms of location lighting, placement or physical obstacles, affect the ergonomics and usability of the installation. We experienced some issues due to the low winter sun that made the LED rings on one side of the installation hard to spot, because they were dimmed by the bright backlight. At the same time the player on the other side was blinded.

We did not have the opportunity to test the installation in various areas, but we asked the interviewees where they could picture it. Airports, shopping malls and areas where waiting time is an issue were frequent answers, and one player said that she "was actually thinking about earlier – We should have had one on each floor [on campus]."[7] An important factor when choosing location for such an installation is the amount of random people and strangers the player is exposed to. Some players did not want a large audience, and said that the installation should be in "preferably not a place where you are very exposed, so

that not everyone can watch you play."[8] Others did not care as much about the potential judgement of strangers:

> It would have been fine by me, I think. I think maybe some would have found it intimidating, but I don't think it [the activity] demands you to do embarrassing things that would make you feel on display.[9]

Some even valued having an audience to push them to perform: "I think it would have been just fine! Maybe I had become even more competitive, to try to win."[10] If an audience was unavoidable, there was approximately a 50/50 distribution among the interviewees if they preferred the audience to be people they knew or strangers.

Location
Key Findings:
- Location elements, such as lighting, may affect the installation usability.
- Users could picture the installation in areas where people usually wait.
- Some users may feel insecure performing activities in front of strangers.
- Some users are motivated to perform well with an audience.

Passer-by Decoding

Finke et al. describes the first glance at an installation as crucial in the user's decision of whether or not to engage with it. This is when the user decides if the installation is of interest to them, and if so, the decoding of the installation starts immediately. Figure 9.7 shows a series of images of a student (outlined in red) passing by the installation. Firstly, he notices the installation and looks at it for a few seconds (image 1) before looking away (image 2). Before the installation will be out of sight, he turns around and stops to take a second look (image 3). We did not have the opportunity to talk to him, but it is natural to assume that he tried to figure out the purpose or functionality of the installation. The student in Figure 9.8 was clearly saying something related to the installation and stretching out his arms, as if he was playing, when passing by.

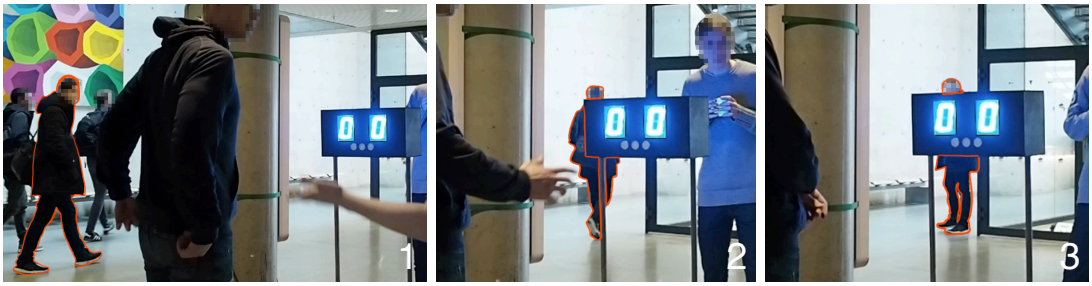


Figure 9.7. Passer-by showing interest in the installation.

Figure 9.8. Passer-by referring to the installation when passing by.

Passer-by Decoding
Key Findings:

- Passer-bys quickly start to decode the installation.

Installation Buzz

The test sessions were conducted during the day, from 9 am to 1 pm, outside three lecture halls. The crowdedness of the installation area is visualized in Figure 9.9. At NTNU, lectures typically run for two 45 minutes sessions, starting at 8:15 am, 10:15 am, 12:15 pm or 2:15 pm, with breaks at 9, 11, 1, etc. During the 15 minutes break between the two 45 minutes sessions (marked "Lecture break"), the lecture halls emptied, and many people stayed in the area of the installation, mainly because they wanted to stay close to the lecture hall. During these breaks we experienced great interest in the installation, particularly from groups of friends. In contrast, the breaks between *different* lectures, meaning the breaks at 10 am, 12 pm and 2 pm (marked "No lecture"), were quieter, except

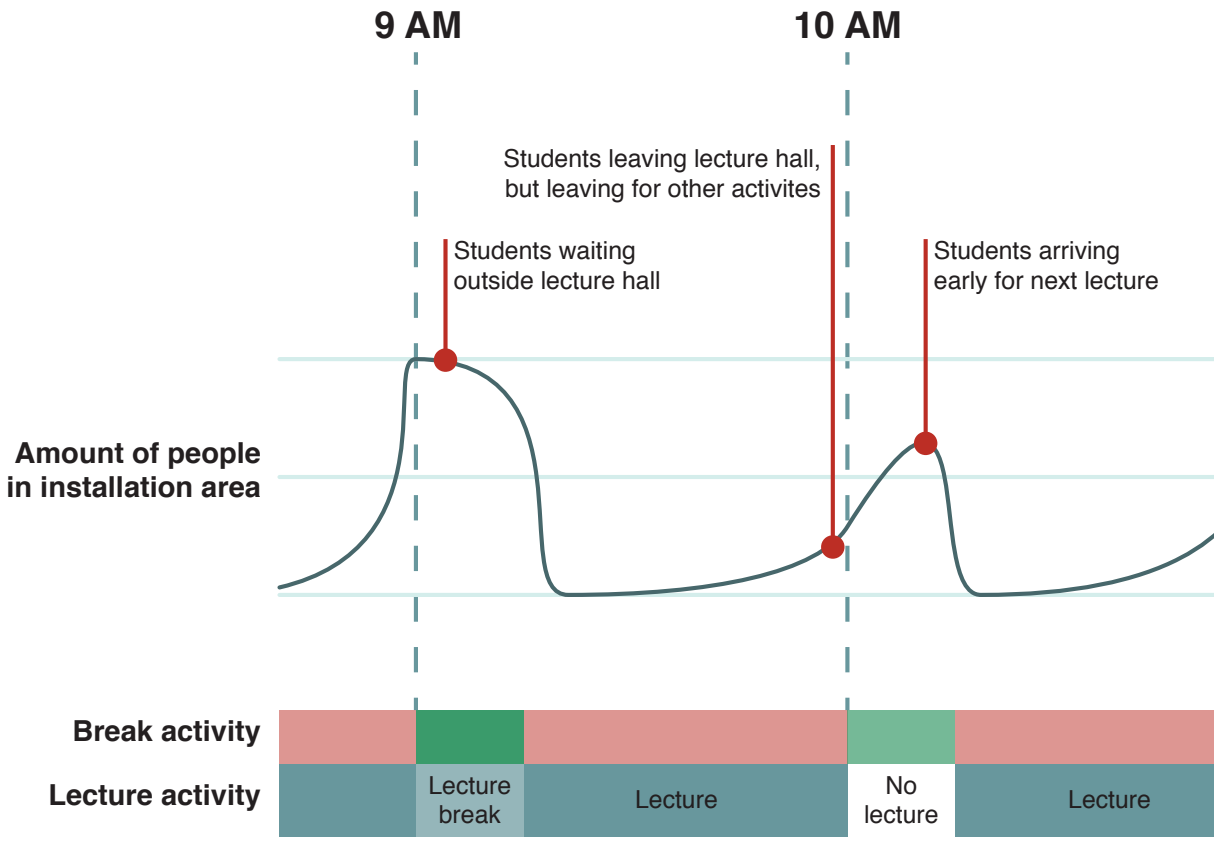
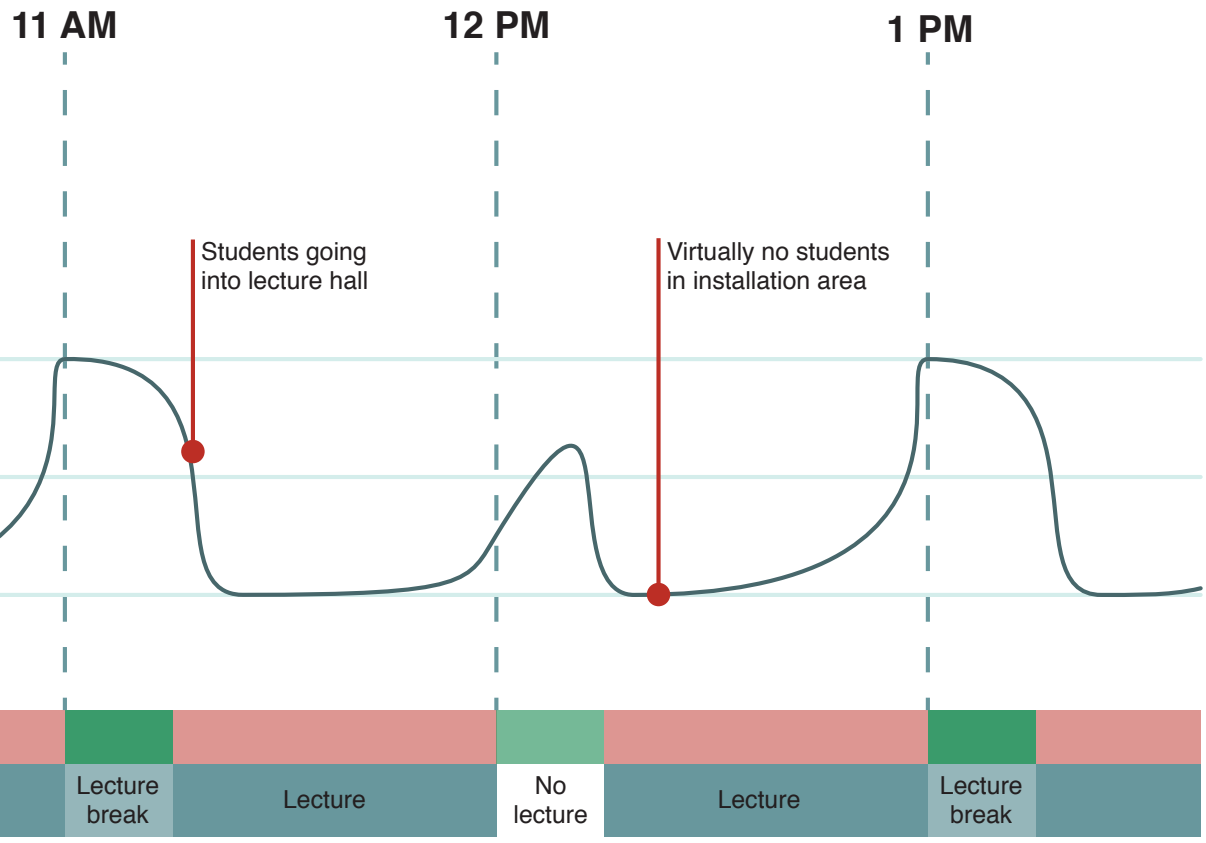


Figure 9.9. Installation area crowdedness.

for students arriving early for their next lecture. We tried catching people on their way out of the lecture halls, but they were all quite determined on getting to their new destination as quickly as possible. Also, during the 45 minutes, where most people were inside the lecture halls, we experienced little to no activity around the installation, even though there were people sitting by, waiting for something or passing by.

This helped us estimate installation activity and demand, and gave us time to organize collected data and fix issues related to the installation or our recording tools, but left long periods of down time regarding the data collecting.



People who passed by when the installation was empty, typically moved right on, but many came back to play when they saw someone else playing, like this interviewee: “I saw that most people, when no one was playing already, just passed by and I think maybe I would have done the same thing too, at least if I didn't know what it was.”[11] The person highlighted in Figure 9.10 watched an entire session, performed by participants she did not know. She had passed by the installation earlier, on her way into the lecture hall, but did not approach us at that time, so seeing others play may have motivated her to stay and watch, before eventually participating herself.

Even though seeing others play lowered the threshold for participation, some eager players needed a little nudge in the form of an active invitation from the research team. One participant said in their interview that “I was hoping you would ask, because I had heard someone else play it, and it sounded fun.” This participant was familiar with the functionality of the installation, but still needed to be practically “allowed” to engage. This applied to several participants that needed approval from either us or their friends to participate: “you see that many people want to try it during the break. [...] We were standing there for a while and all my friends were like ‘I want to try’ so I was like ‘Yeah, do it, do it!’”[12]

Installation Buzz
Key Findings:

- The lecture schedule for the installation area created long periods with very few game sessions, but great interest during the lecture breaks.
- Seeing the installation without players discouraged passer-bys from participating themselves.
- Some participants needed an extra nudge from the project team or their friends in order to participate.

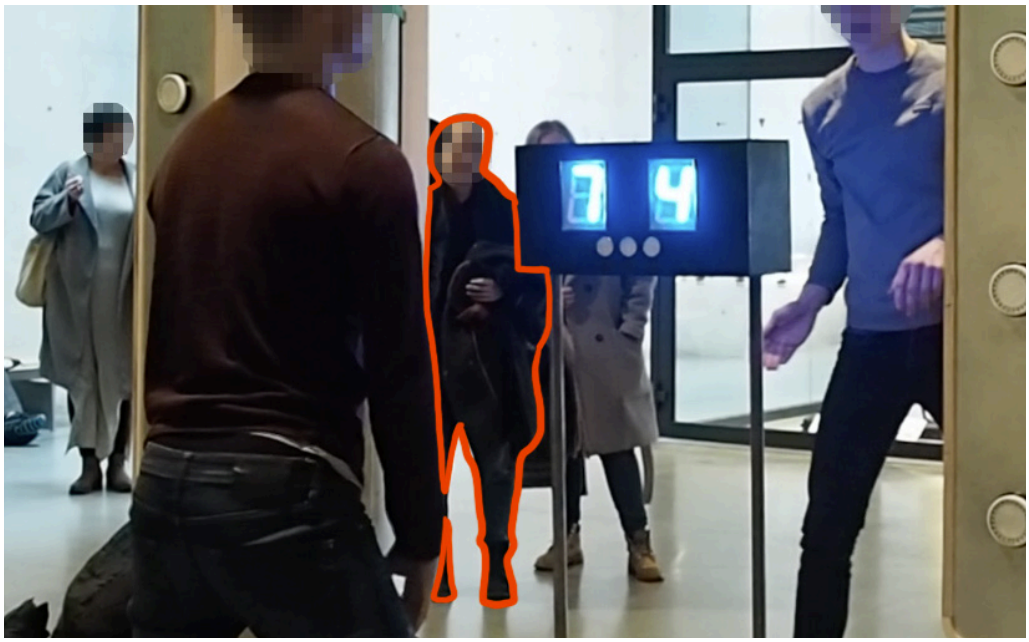


Figure 9.10. Audience member watching a game session before participating herself.

- Discovery
  - Word of Mouth (WOM)
  - Expectations
  - Location
  - Passer-by Decoding
  - Installation Buzz
- Audience
  - Motivation to Engage
  - Peer Learning
  - Demotivating Factors
- Playing
  - System Comprehension
  - Game Approach
  - Communication
  - In Game Motivation
  - Demotivating Factors
- After Game
  - Sense of Accomplishment
  - Feeling of Break
  - Physical Activity Level
  - Motivation for Repetition
  - Passing on the WOM

9.3 The Audience Stage

Defining audience members in this sort of situation can be done in various ways. In this case, we define the audience as people who stay in relatively close proximity of the installation for a relatively long time, while actively observing other players interacting with the installation. This does not include passer-bys, bystanders or persons who stop to watch for only a few seconds.

In this section, findings related to the role as an audience member, such as a) users' motivation to engage, b) audience entertainment, c) peer learning and d) waiting time will be presented. It will not include the effects of an audience on the player, which is presented later in Section 9.4 The Playing Stage.

Motivation to Engage

Participants had a range of reasons for wanting to participate. Through interviews, we found that the main motivational factors were a) that the activity was available, b) curiosity and c) the competitive concept of the installation.

Availability of an Active Break

I know, from personal experience, that the everyday life of students can be demanding. It involves long days of studying and going to lectures, where a sense of concentration and focus is required. To keep that focus, it helps to take good breaks. Without debating what makes a *good* break, we can define a break as an activity that greatly differs from the activity one was initially doing. One can also wonder if break activities that over time become a routine, are no longer as effective. Nonetheless, many students find taking good breaks challenging, and they often end up in an inefficient half work/half break mode. To counteract this, an important goal of this project was to supply the students with an unordinary, active and available break alternative. 78.9 % of the participants thought that the installation being an unordinary activity contributed a lot or very much to their enjoyment of the game, like these two interviewees that liked the game because "it was just a game, it was just doing something else than everyday life,"[13] and "it may be the fact that it is physical play. And maybe that it stands out a bit, that it's a bit different."[14]

There are approximately 18,600 students affiliated to NTNU Campus Gløshaugen (Appendix H). We have estimated that there are about 10 ping-pong tables available on campus, meaning that at any time only 20 students – about one out of a thousand – can play ping pong. A participant stated that "On Stripa [area on campus], for example, that ping-pong stuff is fun, but I don't bother going there just to play ping-pong,"[15] insinuating a positive attitude towards physical break activities, but that the availability of existing activities is not good enough. Beyond ping-pong and a few foosball tables there are, to our knowledge, no other installations offering physical activity on campus.

We asked our interviewees what it would take for them to use the installation frequently, and availability was highlighted by many as a requirement: "The breaks are often spent doing something because you get a little sedentary. So I usually go for a walk, because there is really nothing happening here."[16] Multiple participants explained that they move between different lecture halls all over campus every day, and that the presence of opportunities for physical activity in itself can be motivation enough to engage. Knowing if the installation is available,

i.e. not used by others, can also be a requirement, like for one passer-by that asked us: “Will you be here awhile? Can I try later?”[17] So, for students to use the installation frequently, it should have several locations around campus, and should be available for spontaneous interaction.

Curiosity Towards a New Activity with Inviting Design

#	Contribution to enjoyment	Not at all	A little	Some	A lot	Very much	No answer
2.8	**Unordinary activity**	0	4.4	14.9	29.8	49.1	1.8

From Table 9.3.

The participants were all first time users, making the novelty of the product an important motivation to engage. The majority of the interviewees stated, as mentioned, that they wanted to try the game just because they wanted to check out what it was. 78.9 % of the participants thought that the activity being unordinary contributed a lot or very much to their enjoyment of the game (question 2.8) During down time, when the installation was not in use, people would notice the pulsing green light and give the installation an extra glance when passing by. Some even touched the pulsing button, probably wondering what would happen if they pressed it. One passer-by pointed to the installation and loudly asked her friend “What the hell is that?”[18] It was difficult to interpret if the question was sincere or sarcastic, but it clearly communicated a curiosity towards the installation. The looks of the installation was pointed out by interviewees as a motivating factor to engage: “And it looks well made, it looks professional in a way.”[19] “Cool design and it seemed really neat. And I think the concept was very fun.”[20]

Competitive Concept

As mentioned, newly arrived audience members would frequently ask us if the game was competitive. When we told them that it was, many became clearly excited and motivated to try the installation themselves.

> I: What made you want to try it?
> T: It was just to see what it was, to compete with my mate.
> I: Was that your main motivation or was there something else that made it motivating?
> T: No, I think that was the main motivation yes.[21]
>
> I: Was there anything special that made you want to play?
> T: It was the motivation to beat the opponent, then. (Laughter)[22]

Both of these interviewees had played the two-player game. The competitive spirit was also present in the one-player game, where groups of friends would take turns of playing, to try to reach the highest score.

Entertainment
Not all audience members would move on to becoming participants, for different reasons. Some did not have the time, while others simply did not want to. However, we saw that the audience, mostly and clearly was amused by watching others perform the activity. This included cheering on their friends, laughing and discussing tactics. Being entertained by the activity motivated many to participate themselves, like this interviewee remarking that he wanted to play because "it looked fun, it was fun to watch at least!"[23]

Motivation to Engage
Key Findings:
- The installation, as an unordinary activity, worked well as a break.
- There was a positive attitude towards physical break activities.
- The availability of the installation is key for student interest.
- Users were intrigued by the novelty of the activity.
- A professional looking design invites participation.
- The competitive concept was motivating to many users.
- Participants were motivated by being entertained while watching.

Peer Learning

The participants who had been watching someone else play had less need for an introduction to the game, because they had learned from watching others play. Many also said in their interviews that they thought the game was easy to understand because they had been watching others (eg. "[it was easy to understand because] I had looked at it a bit when I stood next to it"[24]), or had got an introduction elsewhere. Those who had watched for a while also showed a greater confidence when approaching us and the installation, and they seemed more excited and ready to play. Among the audience, clear events of peer learning (Wouters et al. 2016) were happening. We saw groups of friends discussing tactics and the different aspects of the game. Figure 9.11 shows students evaluating their tactics in the game after a game session, which illustrates the continuing learning process related to the installation.

Figure 9.11. Students evaluating their strategies after the game session.

Peer Learning
Key Findings:
- Discussing tactics and installation functionality with peers helped audience members learn the game before playing themselves.

Demotivating Factors

Audience Raising Participation Threshold

Having an audience can be intimidating. Therefore, we asked all participants if and how an audience would affect their wish to participate. Their opinions on the matter were somewhat contradicting. Some thought that an audience would not affect their participation at all, while others could handle an audience if it was relatively small:

> T: No, of course it would have been more pressure then. I don't know, I don't think it's such a cool thing to play in front if there had been like 20-30 people in a ring around me watching. [...] I might not be the kind sticking my nose out. [...] So it might have influenced my desire to play.
> I: In a negative way, or?
> T: Yes, if there had been a lot of people.[25]

> It depends a bit, if it's a really big crowd I can probably feel some discomfort around it, but if it's more like the normal amount of it here at school, I think it would have gone just fine.[26]

No participants reported that an audience would completely prevent them from participating. The reason for this is probably that people who do not like having an audience did not participate in the study to begin with.

Duration and Waiting time

#		Completely disagree	Somewhat disagree	Neither disagree or agree	Somewhat agree	Completely agree	No answer
1.1	I found the duration of the game to be too short	22.8	24.6	26.3	21.9	4.4	0

From Table 9.2.

We see that the responses to whether the duration of the game was too short were quite well distributed across the scale, except for *totally agree*, which means that quite few (4.4 %) had a strong opinion that the game was too short.

The one-player game could last as short as the player liked, because it could end at any score. The two-player game had, in contrast, a lower duration limit, because the game only ended after completing the three sets. Also, by having three sets with nine points per set, the two-player game had an upper session duration limit. This may be the reason that most two-player sessions were quite similar in duration, generally lasting from approximately 1 minute 20 seconds to 2 minutes 10 seconds. The game duration was not particularly mentioned in the interviews, but the few who did so emphasized the short duration as a positive aspect of the game, such as “It was very fun, that is. Such a small, fast game between two players.”[27] and “It is so short that it was okay to start without it taking too much time.”[28]

The duration of the single-player games varied depending on the players efforts in the game – the greater the effort, the longer the game duration. The one-player game sessions generally lasted shorter than the two-player sessions, mainly ranging from 40 seconds to 1 minute 40 seconds. Graphs showing the duration of all game sessions are shown in Appendix I.

The participants, as mentioned in the availability section, were not interested in waiting for a long time to participate. One participant said that “Had there been a very long wait, I would probably have left and checked back later,” followed by “when there is a queue, then people do not play multiple rounds, that’s only rude, so then it would have gone pretty quickly. So I wouldn’t mind waiting a bit.”[29] Another player highlighted that if he had played the game before, and still thought it was fun, he probably would bother to wait in line for a little while, depending on the length of the waiting line. A shorter, manageable waiting line was actually also, by some participants, highlighted as a positive factor, symbolizing that the activity was worth the wait. None of the interviewed participants would, however, risk being late for a lecture because they were playing.

Demotivating Factors
Key Findings:

- A relatively small audience was manageable for all participants.
- The duration of the game was short enough to allow for multiple game sessions within a 15 minutes break.
- Participants highlighted the short duration as a positive factor.
- Long waiting time discouraged users from participating.
- A shorter waiting time could communicate activity popularity in a positive manner.

- Discovery
  - Word of Mouth (WOM)
  - Expectations
  - Location
  - Passer-by Decoding
  - Installation Buzz
- Audience
  - Motivation to Engage
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  - In Game Motivation
  - Demotivating Factors
- After Game
  - Sense of Accomplishment
  - Feeling of Break
  - Physical Activity Level
  - Motivation for Repetition
  - Passing on the WOM

9.4 The Playing Stage

After being part of the audience, the next step is to interact with the installation. In this section findings related to the playing experience is presented. This includes a) how users learn the installation functionality, b) different user approaches to the installation, c) communication between players and audience and d) users' motivation to stay in the game.

System Comprehension

Participants were, as mentioned, given a swift introduction to the installation functionality, and many had the opportunity to participate in peer learning prior to playing. These participants proved to quickly understand what to do in the game. Some participants transitioned very quickly from arriving in the installation area to becoming a participant, and had little to no clue about how to perform the installation activity. For them, the intuitivity and functionality communication of the installation itself became essential to their game success and experience with the installation. In this section, participant system comprehension, based on installation elements such as auditory and visual effects are presented.

Auditory effects

#		Completely disagree	Somewhat disagree	Neither disagree or agree	Somewhat agree	Completely agree	No answer
1.6	The sound effects made the game easier to understand	14.0	15.8	35.1	16.7	12.3	6.1
1.7	The lights made the game easier to understand	1.8	0.9	5.2	18.4	72.8	0.9

From Table 9.2.

#	Contribution to enjoyment	Not at all	A little	Some	A lot	Very much	No answer
2.3	Sound	24.6	26.3	24.6	14.0	2.6	7.9
2.4	Lights	0	4.4	17.5	41.2	34.2	2.6

From Table 9.3.

The questions about the sound and light effects in terms of system comprehension gave very varying results. This was somewhat anticipated as the game was designed to function well even without sound effects, which were added for extra feedback and as an entertaining touch. The participants were very divided in their opinion on the learning benefits of the sound effects, and this question (1.6), of all the questions in part 1 of the questionnaire, had the highest score for *Neither disagree or agree* (35.0 %). Additionally, it had the highest score for *No Answer* (6.1 %). This may have been a coincidence, but may also indicate an uncertainty in the participants. We see a similar division in the questions about factors contributing to the enjoyment of the game. While most of the participants thought that the lights contributed to their enjoyment, the sound did not contribute as much (questions 2.3 and 2.4). The same disagreement was evident through the interviews as well. Here are examples of opinions about the effect of the sounds in the game:

> It beeped when I pressed it [the buttons], I think. [...] It was, in a way, a confirmation that you actually did press them. They [the lights] do not just disappear, because then it is not so easy to notice if they actually disappear.[30]

> No, it [the sound effects] may have had it [an impact on me in the game], but I don't know if it was low or if I just zoned it out or what it was, but I didn't really notice if there was any sound there. [...] No, because I think sound can make things more engaging, but here, at least, it wasn't something I was thinking about at all.[31]

> I didn't really notice very much sound, but I would think that sound would make me understand that I was losing lives, but ... But I don't feel like it had that much of an impact on me here now.[32]

The first statement clearly shows an understanding of the intended functionality of the audio feedback, and appreciation of it, while the second and third statements show that the sound was not loud enough or got zoned out as unnecessary noise.

Visual effects

The lights however, contributed very well to the players' understanding, according to the questionnaire. As much as 72.8 % completely agreed that the lights made the game easier to understand. The interviewees were asked "Were there any particular elements that helped you understand the game?"[33] These

are examples of answers:

> I mean, [...] it's a simple concept that where it lights up, you have to press.[34]

> The lights. Then I understood what I had to do.[35]

> I think it was good that there was a timer on the buttons themselves, because it helped [...] And then it was suddenly: "Oh, shit, I'm about to.. it's about to die!" I'll have to be quicker on this one than that one.[36]

> I think the way the lights work is very intuitive. You see that one button is lit – press the button. There comes a start signal, and then a button lights up with a countdown, and then it's very intuitive. Press this and when eventually red buttons come – don't press red, and the [red button] is static, so it's kind of like, yeah ... I think it works really well.[37]

The first two statements highlight the lights themselves as comprehension building elements, while the last two highlight the countdown effect on the green buttons as something that triggers the intuition. The fourth statement was given by one of very few participants that noticed and mentioned the difference in dynamics in the green and red lights. The color-coding was well understood by the majority of the players. Participants were not always prepared for the red buttons. Their surprised faces and suddenly hectic movements, typically created laughter for both the participants and the audience. We saw many times that the players would reach for the red button *and then* register its color, and withdraw from the pressing action. Figure 9.12 shows two players both reaching for a red button, before both deciding not to press it. Throughout the remainder of the game, red buttons were just registered with only maybe a twitch as the reaction.

The majority of the interviewees also stated that the color-coding was easy to understand.

> It was okay, when it's color-coded it's easy to see, and it's a great contrast to them, so it's easy to figure out [...] which ones to press.[38]
> After all, it was pretty intuitive to figure out how to press the green buttons and avoid the red ones. Meets most such principles so it's pretty obvious.[39]

Some players did not question the meaning of a red button at all, confidently pressing them without any hesitation, like the players in Figure 9.13. They stopped pressing the red buttons after being informed that they gave minus

points. This point deduction was visible on the scoreboard display, but most participants stated that they were too focused on noticing active buttons, that they did not pay much attention to the scoreboard during the game session.

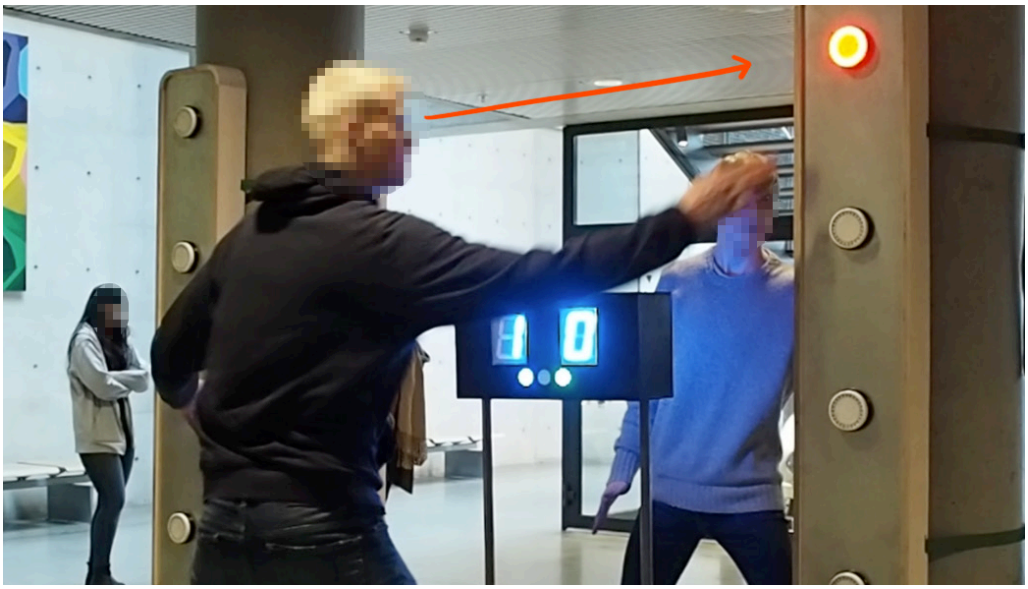


Figure 9.12. Players reaching for a red button.

Figure 9.13. Players confidently pressing red buttons.

System Comprehension
Key Findings:

- Game elements were essential for system comprehension.
- The visual effects contributed more to users' understanding than the auditive effects.
- The sound was too low, or was buried in other noise, for many participants to notice. As the less critical game element, the sound was zoned out by many participants.
- The color-coding and the button countdown were comprehension building elements

Game Approach

The 114 participants showed various approaches to the installation. Some went in with a playful and curious attitude, while others expressed a more serious, competitive mood.

Playful Approach

#		Completely disagree	Somewhat disagree	Neither disagree or agree	Somewhat agree	Completely agree	No answer
1.5	I would categorize this game as play	0.9	1.8	2.6	21.9	71.9	0.9

From Table 9.2.

93.8 % somewhat or completely agreed that they would categorize the game as play. One eager participant told his less eager friend that "I can't play [Norwegian: Leke] without you"[40] further supporting that the installation activity was perceived as play.

Measuring playfulness is challenging, because the characteristics of it are rather diffuse, and the word can have a different meaning to different people. In our interviews we relied on the participants' self reporting by asking them if they considered themselves as playful persons. This question led to some hesitancy, and very few managed to give a clear and concrete response. One of the responses to this question was: "Yeah, I feel I'm kind of childish, so I think it would have been fun to just keep doing it [playing]."[41] What is interesting

about this response, is the reference to childhood – the participant immediately associated the word “playful” with being childish. It testifies that the playful attitude or playfulness as a concept is linked to childlike behavior. It seems like playfulness is a mood or predisposition many adults do not easily relate to or have reflected much on, even though most people, in some way, have playful qualities.

The participants in Figure 9.14 showed a playful approach to the game both by moving frivolously around the installation, with humorous commenting and laughter during the game.

Figure 9.14. Playful approaches to the installation. Visually apparent through frivolous and whimsical body language.

Stickler for Rules

Based on our understanding of playfulness, we did, however, manage to see a sort of distinction between playful and non-playful persons through their attitude towards the rules of the game. All players (except those who did not need it) got a short introduction to the game, where the goal of pressing green buttons as quickly as possible was explained. The interviews showed that some got annoyed by not knowing the complete and exact rules of the game.

> Maybe it was the premise ... I mean, clarification of what to do, what to press and how to do it. We were informed that the level of difficulty would increase, but that there would be two [buttons] at the same time, for example, that I was not ready for, somehow. [...] Preparing rules, maybe. That you should not press the red [button]. Depends on what the purpose of the game is. Whether to measure what you learn along the way... I don't know.[42]

This player expressed a desire to know the purpose and the rules of the game. Earlier in the interview the participant had also asked if the purpose of the game was to have fun or to measure something. This participant, like many others, gave off an attitude of wanting to play the game correctly, instead of taking the playful and explorative approach as we saw with other participants, where the rules or the purpose were not as important.

Bodily Strategies

The variation in the game led to participants having to adjust their stance or body movement throughout the game. We saw multiple ways of physical, bodily tactics – ranging from somewhat static, mainly moving in the vertical axis, often seen with tall participants with longer arms; to more dynamic, moving in both the vertical and horizontal axis, often seen with shorter participants (Figure 9.15).

Figure 9.15. Participants using different bodily tactics.

The participant in Figure 9.16 tested multiple variations of his stance and adjusted the extension of his arms between button presses, until finding a satisfying posture.

Figure 9.16. Participant adjusting his posture.

Game Approach
Key Findings:

- While the majority of the participants considered the activity as play, not all had a playful approach to the installation.
- The installation successfully facilitated both an explorative and competitive approach.
- Bodily strategies were tested and developed to adjust to personal, physical features.

Communication

During game sessions we saw various types of social interaction and communication. Verbal communication happened mainly between participants or between participants and the audience, like illustrated in the timeline (especially images 4, 6 and 7) in Figure 9.17. Communication between players generally consisted of short comments when buttons were reached or missed, or outbursts of surprise, like in image 3. Bodily expressions were frequently used to manifest the mood of the game, e.g symbolizing competitive spirit (image 2) or physical exhaustion (image 6).

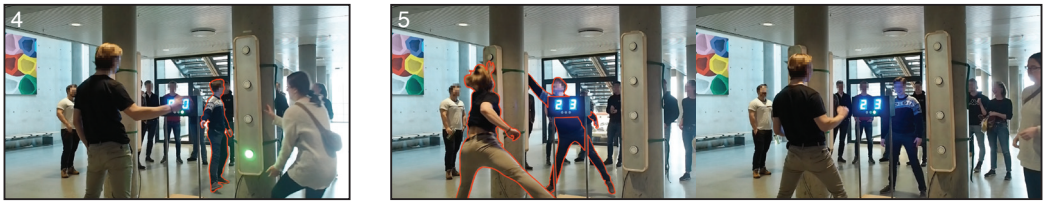
Interviewed participants valued being able to see and communicate with their opponents, because it made the game session feel like a shared experience between friends: “[playing with others] is the whole point, if not I could sit on the phone, that’s mainly why I played.”[43] “It is fun, because then you are in it together. It... shared experience and can laugh a bit, if, hopefully...”[44]

00:00:00-00:00:28 | 00:00:40 | 00:01:13

Both players stretching to check dimensions. Physically and mentally preparing for game.

Player eagerly clapping his hands to signalize “game on!”.

Players and audience suprised by the rapidity of the start animation.



00:02:02 | 00:02:15

Player turning towards audience, between sets, to explain his tactics in the game.

Both players struggling to reach the same button. Leads to laughter for both players and the entire audience.

00:03:07 | 00:03:19 | 00:08:50

Both players show very expressively that the game was exhausting. “I got tired!”, “I got really tired, too!”

Two people from the crowd yell “now it’s our turn!” and immideately get ready by the installation.

After finishing our questionnaire, they return to the installation to discuss their different tactics.

Figure 9.17. Timeline from video segment, showing player-audience communication.

Participants stated that the communication through body language and movements was helpful during the game session, e.g. to spot active buttons:

> Yes, that is, when I did not see where the buttons were, I saw that she was moving to that side, for example, and then in a way I followed a little, or just that reflex, if you understand what I mean.[45]

Playing with Strangers

When the two-player mode was set up, students who were alone would rarely approach the installation, and if so, they would withdraw as soon as they knew it was a two-player game. Inviting strangers to join them was not an option: "I don't think I had come here and found a random person, exactly, to play against."[46] With the one-player game, it was naturally easier for individuals to engage by themselves. The attitude toward playing with strangers was divided in the interviews. Some thought it may have been just as playing with a friend "because it is not such a personal game,"[47] while others could not imagine playing with strangers at all: "I have no need to compete with anyone other than people I know."[48]

Communication
Key Findings:

- Participants communicated with both opponents and the audience during game sessions. This communication was reported as valuable.
- There was not observed or reported any specific interest in playing with strangers.

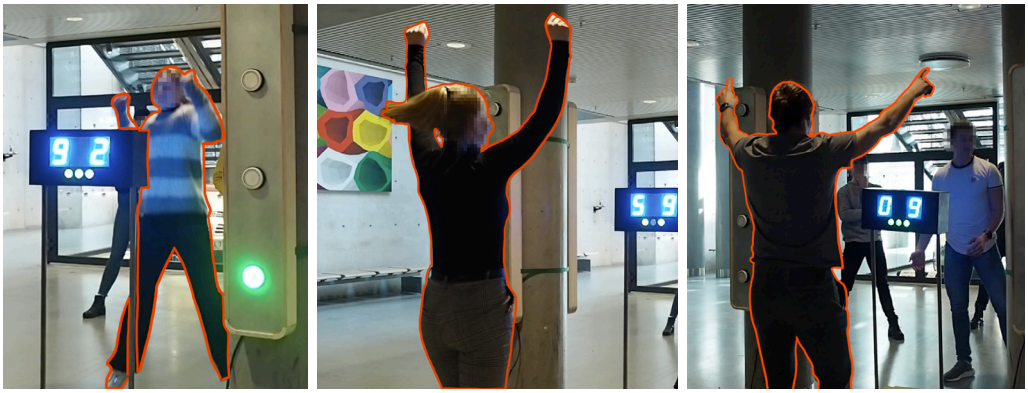


Figure 9.18. Victory poses communicating competitive spirit.

In Game Motivation

Competition

#	Contribution to enjoyment	Not at all	A little	Some	A lot	Very much	No answer
2.2	**Competition**	0	1.8	6.1	28.0	60.5	3.5

From Table 9.3.

In addition to being an important motivation to engage with the installation, competition was a major motivation to stay in the game. This was obvious through observation, where competitive body language was evident (Figure 9.18); interviews, "I wanted to win, simply!"[49] and the questionnaire, where 88.5 % reported that the competition contributed a lot or very much to their enjoyment of the game, regardless of which game mode they had played.

Both through observation and interviews, we saw two types of competitive spirit: Aimed at the opponent, *competitive*, or at oneself, *self competitive*. From the interviews we found evidence of both attitudes through statements like the following:

Interview question: After starting the game, what were motivational factors for you?

Competitive answer: "To beat the one I played against."[50]

Self competitive answer: "It is the competitive instinct in general, that you just want to score as much as possible."[51]

These answers were given by different participants, and they clearly highlight different aspects of competitive instinct. These players played different game modes – the competitive response was given by a player of the two-player mode, and the assertive response by a single mode player. This may suggest that competitive instinct is directed towards the other player, when an opponent exists, and towards oneself or the game itself in single player games. However we saw signs of self competition as motivation also in the two-player mode, such as wanting to win back points lost to accidental pressing of red buttons: "I wanted to try to do better with the other buttons, so I could get my points back."[52]

The sense of self competition as motivation was evident in many one-player game sessions, such as the player in Figure 9.19 who did a little dance for himself when he reached a score he was happy with, or the participant in Figure 9.20 who was disappointed by his effort. Another participant took his hoodie off before the game started, and explained that “I just need to take this off. I don’t take this competition lightly.”[53]

Figure 9.19. Participant doing a happy dance.

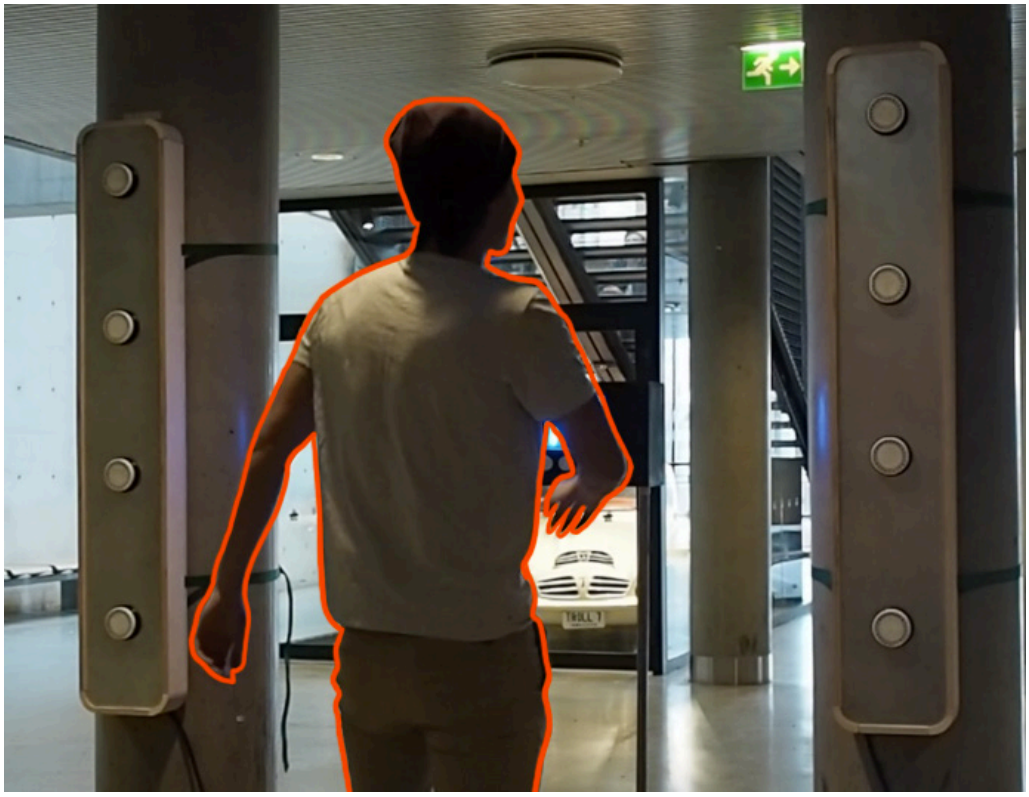


Figure 9.20. Disappointed participant.

Variation Demanding Mental Focus

#	Contribution to enjoyment	Not at all	A little	Some	A lot	Very much	No answer
2.7	Concentration requirement	0	0.9	4.4	33.3	59.6	1.8

From Table 9.3.

The game has a gradual development, thus demanding a certain level of mental focus from the player. Participants highlighted the variation in terms of increasing speed and number of active buttons as a positive feature, and clearly appreciated the combination of physical movements and focus: “You get to use the body and the mind at the same time!”[54]

The mental activity intensity of the game was brought up by many interviewees when asked about their motivation to stay in the game or what made them like the game. “You get a bit on guard, kind of. Because when it lights up more, then you become more alert.”[55] “You can feel it pumping a bit, and you become more vigilant.”[56] 92.9 % of the questionnaire respondents reported that the requirement for concentration contributed a lot or very much to their enjoyment of the game. This factor, along with competition, had the highest mean value. Some players were so engaged in the game that they seemed to forget about their surroundings (Figure 9.21), causing one participant to slip on the floor (image 1) and another participant to fall onto the scoreboard when reaching for an active button (image 2).

In Game Motivation
Key Findings:

- The majority of the participants enjoyed the competitive aspect of the installation.
- We saw two types of competitive spirit: Directed at the opponent, or at oneself.
- The participants enjoyed the demand for concentration and mental focus in the game.

Figure 9.21. Participants forget about physical surroundings, slipping on the floor and crashing into the installation.

Demotivating Factors

Color Blindness

Approximately five participants were color blind. Most of them went confidently into the game, but when informed about the red buttons, their confidence decreased noticeably, due to their fright of pressing the wrong buttons. The red and green buttons should, as mentioned, have been possible to distinguish from each other because of the difference in dynamics, but as the pace of the game was quite high, buttons were often pressed before the countdown was noticed properly. After pressing two red buttons, the player in Figure 9.22 was informed about the minus points by his friends in the audience. He turned to them to explain that he is colorblind. His friends laughed, and for the remainder of the game, he hesitated on almost every button press and already seemed to have given up.

Figure 9.22. Player turning to friends, mid game, to explain his color blindness.

Confusion

There were some cases of confusion related to the button colors and number of active buttons. One interviewee said that “I didn’t quite understand what the yellow and the red buttons meant.”[57] The yellow being the last few diodes in the green countdown. Figure 9.23 shows participants experiencing the same

confusion, where they both hesitated to press a green button because the diodes turned yellow. The player to the left even stopped and pointed questioningly at the button. We saw multiple times during observation, that if one player was hesitant, the other would become unsure too. The confusion of the yellow diodes was evident in many game sessions (Figures 9.24 and 9.25) The start of the second set in the two-player mode often led to some confusion where phrases like “Oh, what? Are we pressing two at the same time?”[58] were frequently heard.

Frustration regarding the red buttons was expressed in some interviews, as something they wished they were informed about before game start: “No, I mean, in the heat of the moment you don’t think that there are minus points, when you’re not informed about it in advance.”[59]

Figure 9.23. Players confused by the last few yellow diodes on a green button.

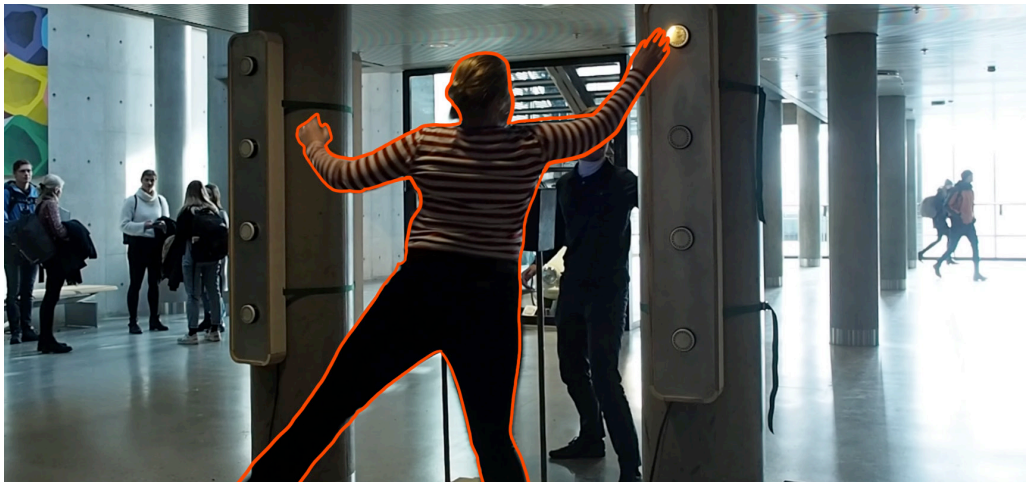


Figure 9.24. Player jumps for a green button, but withdraws when the diodes turn yellow.

Figure 9.25. Both players clearly notice green buttons, but decide not to press them.

A bad connection in the wiring sometimes caused a few diodes on certain buttons to remain lit even after the button was pressed. This made participants think that the button should be pushed again, and distracted them from noticing other, actually active, buttons. Figure 9.26 shows a participant trying to make faulty diodes go away by pressing a passive button several times.

The start animation and the start sound effect appeared, through our observations and video analysis, to create some confusion with the players, even though they had just been informed about it in the introduction. When the Start-button was pressed and the animation started, many players started reaching for and pressing the buttons (Figure 9.27). The lights often stopped flashing before

Demotivating Factors
Key Findings:

- The high speed of the game made the dynamic differences between buttons challenging to notice, especially for red-green color blind participants.
- Some participants were annoyed by not knowing the consequences of pressing a red button.
- The yellow diodes of the green buttons were confusing to many participants.
- Faulty diodes in the LED rings confused participants.
- Confusion can be contagious.
- The start animation was confusing, as the connection between the lights and the sound was not made clear enough.

they could press the buttons, leaving many players clearly confused. There was no doubt that the players' focus was on the lights rather than on the sounds, which is understandable, as focus on the lights will help you succeed in the game, while the sound is more redundant.

Figure 9.26. Participant repeatedly pressing a passive button with faulty diodes.

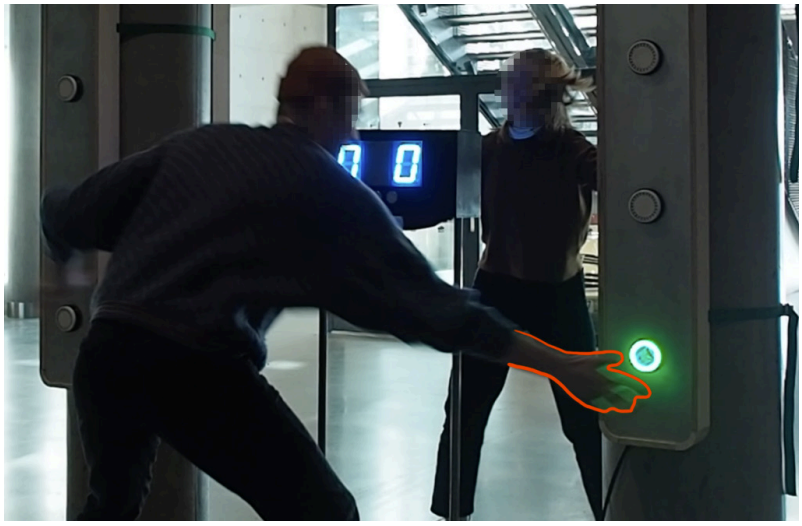


Figure 9.27. Players reaching for buttons during start animation.

- Discovery
  - Word of Mouth (WOM)
  - Expectations
  - Location
  - Passer-by Decoding
  - Installation Buzz
- Audience
  - Motivation to Engage
  - Peer Learning
  - Demotivating Factors
- Playing
  - System Comprehension
  - Game Approach
  - Communication
  - In Game Motivation
  - Demotivating Factors
- After Game
  - Sense of Accomplishment
  - Feeling of Break
  - Physical Activity Level
  - Motivation for Repetition
  - Passing on the WOM

9.5 The After Game Stage

The feelings that one is left with after completing an activity may affect the wish for repetition – like the good feeling you get after a workout session. This section presents a) what sense of accomplishment the participants felt, b) whether they perceived the activity as a good break, c) what their motivations for repetition were and d) whether they would recommend the activity to their friends.

Sense of Accomplishment

#		Completely disagree	Somewhat disagree	Neither disagree or agree	Somewhat agree	Completely agree	No answer
1.3	I found the level of difficulty suitable	1.8	4.4	5.2	32.5	56.1	0

From Table 9.2.

The difficulty level, in terms of game speed and number of active buttons in play, is progressive in the one-player game. It starts at a very manageable level, to ensure that virtually anyone can get some points. This was appreciated by many players: “It was nice to have an intro round where there were no red buttons and stuff, just to get started with the game, so yeah, it helped me get a little into the spirit.”[60] The speed, thus the difficulty, increases until ultimately every player loses. In the two-player game, the difficulty level can be different for the two players depending on the skill level and speed of their opponent. In the second set, two active buttons are introduced. This provides both players the opportunity to collect points, giving them a sense of accomplishment regardless of the score.

88.6 % of the questionnaire respondents somewhat or completely agreed that they found the level of difficulty suitable (question 1.3), and 17 of the interviewees stated that the rules and concept of the game were easy to understand. “It was really easy to understand, actually. I felt I could start right away.”[61] This indicates that most participants felt a sense of accomplishment, which pairs well with the number of victory poses and smiles we saw during testing.

Sense of Accomplishment
Key Findings:
- Participants felt a sense of accomplishment because of the onboarding of the game.
- The majority of the participants experienced the difficulty level as suitable.

Feeling of Break

The demand for physical activity and mental focus should sufficiently distract users from their daily stress and duties. When asked about their mood before and after playing, the vast majority reported that they felt the same or better. Some reported an increased level of energy: “Since I was active, I got to use the energy, and then I got more energy from moving more too. So positive impact!”[62] Two interviewees explained that they experienced a positive mood transition from being tired or bored, to excited and inspired: “[I felt] sleepy, a little tired, I was a bit like ‘oh, long day’. I got a little kick from jumping around, it may sound a little silly to say, but yes, I did. You got a bit like ‘wooo’.”[63] and “Now I'm a little more keen on getting in and learning something actually.”[64]

Feeling of Break
Key Findings:
- Participants experienced a positive mood change from playing.

Physical Activity Level

#		Completely disagree	Somewhat disagree	Neither disagree or agree	Somewhat agree	Completely agree	No answer
1.2	I found the intensity of the game too high	36.8	29.8	26.3	4.4	1.8	0.9
1.4	I feel like I got to use my body	0.9	0.9	1.8	28.0	68.4	0
1.8	I consider this activity fun	0.9	0	0	15.8	83.3	0

From Table 9.2.

#	Contribution to enjoyment	Not at all	A little	Some	A lot	Very much	No answer
2.5	Body movement	0	2.6	8.8	50	36.8	1.8
2.6	Intensity	0.9	2.6	14.9	32.5	47.4	1.8
2.7	Concentration requirement	0	0.9	4.4	33.3	59.6	1.8

From Table 9.3.

We asked our participants if they felt like they got to use their bodies (question 1.4). The question received a quite unanimous response where 96.4 % somewhat or completely agreed that they got to use their body. Additionally, virtually all participants would somewhat or completely agree that the activity was fun (question 1.8). This tells us that the installation contributed to active breaks for the participants, without them feeling like they participated in a work out session, as if the activity being fun camouflaged the feeling of physical activity. We observed many participants who were both a bit out of breath and showed signs of sweating, or at least increased temperature after playing. The participants were all smiling after playing, regardless of which game mode they had tried, and it seemed like the ones who gave the greatest physical effort showed the greatest joy afterwards. “You don't notice that you’re using the body so much, then a little afterwards you realize that ‘Oh, I got a little out of breath actually’.”[65]

Question 1.2 asked whether the players thought the intensity of the game was too high. Very few participants (1.8 %) totally agreed, and quite few (4.4 %) somewhat agreed, meaning the majority (92.9 %) of the players had no opinion about the matter, thought the intensity was fitting or thought it was too

low and not demanding enough. The wording of the question leaves a need for interpretation, as the statement "I completely disagree that the intensity was too high" can mean both that it was appropriate and that it was too low, and thus possibly boring. In question 2.6 of the questionnaire, 79.7 % of the participants said that the intensity of the game contributed a lot or very much to their enjoyment of the game. This tells us that even if some participants thought the intensity was too low, it still may have contributed to the activity being enjoyable. However, we cannot say with certainty that the majority thought the intensity was perfect.

Also, we do not know how the participants chose to interpret the word “intensity” as this may refer to both the speed of the game, the demand for physical movements or mental focus. As the majority thought that both the body movement, the intensity and the concentration requirement contributed well to their enjoyment of the game, we can assume that most participants were happy with the overall level of intensity, regardless of one’s interpretation of the word. Almost none of the interviewees, when directly questioned about it, thought the physical activity level or intensity should have been higher, except for one subject who said that “It would have been no problem if it had demanded more.”[66] This participant was in relatively good physical shape, and further stated that “but some may not have liked that.”[67] Yet, many did state that the physical activity level should not exceed the point where you start sweating. “[The physical activity level was] suitable. For example between lectures, you do not get sweaty, and that is good.”[68]

Physical Activity Level
Key Findings:
- The level of physical activity demanded by the installation was perceived as suitable.
- Participants reported that they got in the zone and forgot that they were performing a physical activity.
- Not becoming sweaty was reported as an important requirement.

Motivation for Repetition

After having used the installation once, interviewees were asked what it would take for them to use it on a regular basis. Availability was, as mentioned, an essential factor. In addition, the ability to a) improve in the game and b) track and beat high score reported factors.

Improvement of Tactics

Being able to experience improvement from play to play was highlighted by several interviewees. This included testing different tactics, to see what approach was more successful, or testing one's abilities against different people.

> then you could somehow measure yourself against yourself, or measure yourself against others on... Yes, for example, I played Tetris before. So every time I always tried to beat my own record, so in the end it doesn't work, but I still try and one day it works.[69]

High Score

There were two players that stood out as the most competitive personalities, including both a sense of competition between the two of them and directed towards themselves and the installation. They had played the two-player mode earlier, and came back to try again. Their motivation to revisit was that the loser from their last play wanted revenge. Before playing, they wanted to know what the high score was, which was somewhere just below a hundred. They started taking turns playing the game, with loud and expressive reactions each time any of them lost with a score below a hundred. They both agreed that they would not leave the installation before one of them had reached the 100 points goal.

Prior to the left image in Figure 9.28, the player was getting close to the score of 90, when someone shouted "Can he reach a hundred?!"[70] from the sidelines. When he did not the player shouted "Damn!"[71] in a both angry and laughing manner, with a big smile. The next time, the player lost at 96, reacting by shouting out "Shit! It can't be true!"[72] while laughing and kicking into the air (right image). A few minutes later, another participant reached the score of 101. The audience cheered and clapped, and the participant was very happy with himself (Figure 9.29). These participants were clearly motivated by the score, and played multiple rounds. Another participant suggested that

> maybe you could connect it to, for example, you could have an RFID scanner with your student card and register your user and get your name and picture and score, and then have it on a weekly basis maybe connected to competition or something?[73]

which he, possibly combined with some sort of weekly reward, thought would motivate regular users.

Figure 9.28. Player reaction after losing.

Figure 9.29. Participant reaching the score of 101. Clearly happy with his own effort.

Motivation for Repetition
Key Findings:

- The ability to improve oneself and develop and test tactics motivated participants to play several times.
- Beating the high score was a strong motivator for repetition.
- A system for tracking high scores was suggested as a potential motivating reminder to play.

Passing on the WOM

#		Completely disagree	Somewhat disagree	Neither disagree or agree	Somewhat agree	Completely agree	No answer
1.8	I consider this activity fun	0.9	0	0	15.8	83.3	0
1.9	I would recommend this to friends	0.9	0	5.3	22.8	71.0	0

From Table 9.2.

We knew that one of the most effective forms of advertising and promotion is the word of mouth (WOM) and personal recommendations between friends. A friend telling you that an activity is fun is much more trustworthy than the organizer of the activity telling you the same thing. Firstly, you generally trust friends rather than strangers, and secondly, your friend is most likely impartial and unbiased, even though their opinion, of course, is subjective. Nonetheless, we considered the degree to which test participants would recommend the activity to friends as a good measure of whether they actually thought the game was good or not. The questionnaire (question 1.8) showed that 83.3 % completely agreed that they considered the activity fun, while a smaller proportion (71.0 %) completely agreed that they would recommend it to friends (question 1.9), testifying that the participants enjoyed the experience.

Passing on the WOM
Key Findings:

- The majority of the participants found the activity fun and would recommend it to their friends.

9.6 Installation Implications During the Data Collection Phase

During the data collection test session, some unfortunate events occurred from time to time that may have affected the outcome of the study.

The Arduino microcontroller is great for many uses, but sound management is not its strong suit. This caused the programmed sound to fail now and then of unclear reasons, and with no evident trigger. From our extensive internet research on the topic, we found that it may be caused by low capacity in the Arduino, which probably should have been replaced by a Raspberry Pi or a microcontroller better suited for use of sound. As this issue occurred during the planned test period and there did not seem to exist a quick fix, we did not prioritize this rather than conducting the tests as scheduled. This led to some participants playing with sound throughout their game, some lost the sound during the game, and some playing completely without sound. We did not register which participants or how many that experienced which of these scenarios.

Just like with the sound, the Arduino has a capacity issue when many tasks are conducted simultaneously. Since the game developed for this study used many LED rings, the level of voltage needed to make them light as intended, almost reached the Arduino's limit. This, in addition to managing sound, button presses and the scoreboard may have been too much for the master Arduino to handle, and led to the game occasionally crashing mid play. As with the sound, this happened with no particular trigger, and could happen in both the most intensive and the calmest of game runs. The microcontrollers needed a reset from time to time in order to run the code properly.

The prototype had to be adjusted between game sessions, due to user manipulation of its position. The force applied by users on the prototype greatly exceeded our expectations, leaving us worried that the installation could be damaged during use.

Chapter 10
Application of Results

10.1 Key Findings

Below, the key findings from the result analysis are gathered and summarized, based on their occurrence in the different stages of the installation experience: a) discovery, b) audience, c) playing and d) after game. Through a thorough data collection, we managed to discover a wide range of factors that influence the user's perception of the installation activity.

Discovery

During the discovery stage factors related to how users are informed about the existence of the installation occur. In this study I have found that the WOM and promotion through social media are effective ways of informing potential users. When users heard about or saw the installation, they started to decode the installation, trying to define its functionality and purpose. Expectations were, too, immediately made, often based on previous experiences with similar activities. The location could also affect the potential user. I found that the users either did not care, or were discouraged by e.g. a too intimidating location. Activity around the installation (Installation buzz) caught passer-bys' attention, and inspired them to approach the installation themselves.

Word of Mouth (WOM)
- Promotion on social media recruited users.
- The word of mouth among friends was a valuable method of promotion.

Expectations
- The activity was expected to be fun.
- Expectations were related to installation functionality.
- Competition was expected.
- Expectations were created by previous experiences.

Location
- Location elements, such as lighting, may affect the installation usability.
- Users could picture the installation in areas where people usually wait.
- Some users felt insecure performing activities in front of strangers.
- Some users were motivated to perform well with an audience.

Passerby Decoding
- Passer-bys quickly started to decode the installation.
- Installation Buzz Lowering Participation Threshold
- The lecture schedule for the installation area created long periods with very few game sessions, but great interest during the lecture breaks.
- Seeing the installation without players discouraged passer-bys from participating themselves.
- Some participants needed an extra nudge from the project team or their friends in order to participate.

Audience

Audience members experienced a range of factors that motivated them to play. They were motivated by the physical activity being new, unordinary and available. The competitive concept was also compelling. The peer learning was appreciated by the participants. A large audience or long waiting time could demotivate the users from playing.

Motivation to Engage

- The installation, as an unordinary activity, worked well as a break.
- There was a positive attitude towards physical break activities.
- The availability of the installation is key for student interest.
- Users were intrigued by the novelty of the activity.
- A professional looking design invites participation.
- The competitive concept was motivating to many users.
- Participants were motivated by being entertained while watching.

Peer Learning

- Discussing tactics and installation functionality with peers helped audience members learn the game before playing themselves.

Demotivating Factors

- A relatively small audience was manageable for all participants.
- The duration of the game was short enough to allow for multiple game sessions within a 15 minutes break.
- Participants highlighted the short duration as a positive factor.
- Long waiting time discouraged users from participating.
- A shorter waiting time could communicate activity popularity in a positive manner.

Playing

When playing with the installation, the game elements were the primary source for system comprehension. The visual effects were more valuable than the auditory. The installation was perceived as play, but not all participants had a playful approach to it. The communication between players and the audience was appreciated, as well as the competition and demand for mental focus. Confusion toward the rules of the game led to frustration for some participants.

System Comprehension
- Game elements were essential for system comprehension.
- The visual effects contributed more to users' understanding than the auditive effects.
- The sound was too low, or was buried in other noise, for many participants to notice. As the less critical game element, the sound was zoned out by many participants.
- The color-coding and the button countdown were comprehension building elements.

Game Approach
- While the majority of the participants considered the activity as play, not all had a playful approach to the installation.
- The installation successfully facilitated both an explorative and competitive approach.
- Bodily strategies were tested and developed to adjust to personal, physical features.

Communication
- Participants communicated with both opponents and the audience during game sessions. This communication was reported as valuable.
- There was not observed or reported any specific interest in playing with strangers.

In Game Motivation
- The majority of the participants enjoyed the competitive aspect of the installation.
- We saw two types of competitive spirit: Directed at the opponent, or at oneself.
- The participants enjoyed the demand for concentration and mental focus in the game.

Demotivating Factors

- The high speed of the game made the dynamic differences between buttons challenging to notice, especially for red-green color blind participants.
- Some participants were annoyed by not knowing the consequences of pressing a red button.
- The yellow diodes of the green buttons were confusing to many participants.
- Faulty diodes in the LED rings confused participants.
- Confusion can be contagious.
- The start animation was confusing, as the connection between the lights and the sound was not made clear enough.

After Game

After having played, the participants felt a sense of accomplishment and that the activity had worked well both as a break and a source for bodily movement. The opportunity for improvement, such as beating the high score, motivated participants to repeat the activity. Participants would recommend the installation to friends.

Sense of Accomplishment
- Participants felt a sense of accomplishment because of the onboarding of the game.
- The majority of the participants experienced the difficulty level as suitable.

Feeling of Break
- Participants experienced a positive mood change from playing.

Physical Activity Level
- The level of physical activity demanded by the installation was perceived as suitable.
- Participants reported that they got in the zone and forgot that they were performing a physical activity.
- Not becoming sweaty was reported as an important requirement.

Motivation for Repetition
- The ability to improve oneself and develop and test tactics motivated participants to play several times.
- Beating the high score was a strong motivator for repetition.
- A system for tracking high scores was suggested as a potential motivating reminder to play.

Passing on the WOM
- The majority of the participants found the activity fun and would recommend it to their friends.

From these findings, we clearly see that the participants of this study had a positive experience with the installation, but a greater understanding of factors that influence potential users in a demotivating manner could have improved the experience even further.

10.2 The Playground Model

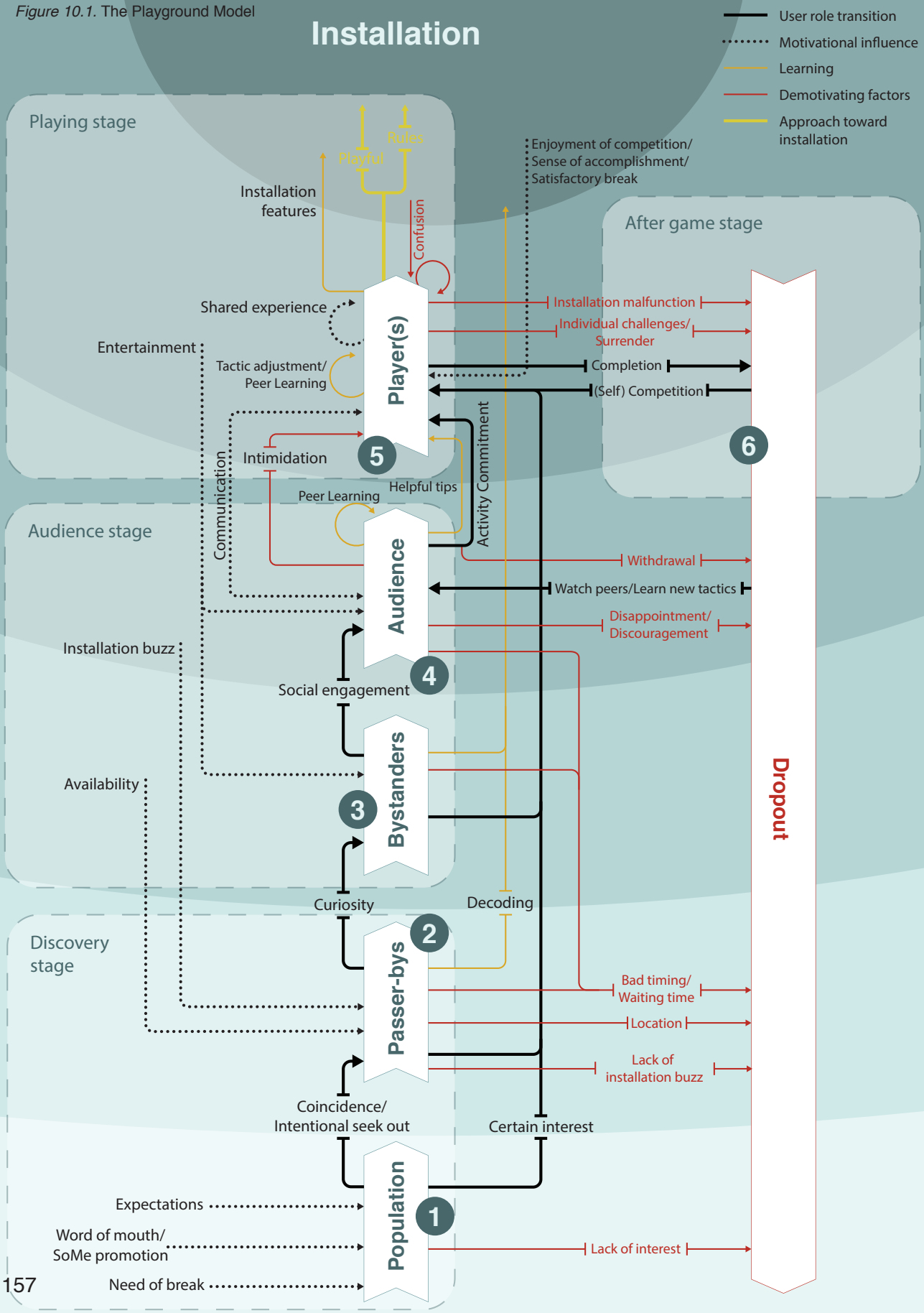
In order to systematize the findings from this study, a visual model was developed. The proposed Playground Model described below should give an overview of the various factors a user of a public interactive system is under the influence of throughout the user journey. The model can also serve as a tool for designers and developers of future public installations. The model (Figure 10.1) is inspired by The Honeypot Model by Wouters et al. (2016), with added elements especially regarding social interaction and motivating factors.

The model covers the user journey, from the idea of the installation or the need for a break being planted in the mind of the user, to the installation activity being completed and potentially repeated, including possible factors leading to user dropout prior to activity completion. It is structured according to the stages of the user journey, as presented in Section 10.1, but the factors are linked to the various roles a user acquires through their experience with the installation. The model includes all substantial matters reported by the participants of this study. The model is applicable to installations designed for one or more players, in the user group young adults, e.g. students. The installation has a certain set of rules, but an explorative and playful approach is possible. The installation is placed in an area with enough space to accommodate an audience, and the installation is visible for people passing by. The installation's visual or auditory feedback and the players' performance is visible and noticeable to anyone in relatively close proximity to the installation.

Factors beyond what is currently presented could not be argued with the available data. Thusly I cannot guarantee complete coverage of the user journey, and I encourage further research on the matter.

In future research I propose that one investigates which factors that can lead the user to re-enter into the user journey after initial dropout. I.e. If a user feels discouraged, how can one motivate this user to retry? If a user experiences situational obstacles, such as installation malfunction or bad timing, what can be done to motivate the user to come back later?

Figure 10.1. The Playground Model



Model Explanation

User Role	Description
Population	All potential users that often or occasionally are in the area of the installation.
Passer-bys	Potential users passing by the installation. Within sight of the installation.
Bystanders	In relatively close proximity of the installation. Passively watching installation activity.
Audience	Is standing/sitting close to the installation. Actively observing/discussing activity.
Player(s)	Actively engaged and interacting with the installation.
Dropout	Has left/is about to leave the installation area.

1 *Population*

The *population* is informed about the existence of the installation through the *word of mouth* or through promotions (made by peers or installation facilitators) on social media (SoMe). As soon as the population is informed, *expectations* are made. This can lead to a *coincidental seek out*, where the user happens to be in the area of the installation and recognizes it from what they have been told by others. An *intentional seek out* can also happen. This is when the user finds the location of the installation with the intention to check it out for themselves. The third alternative is that the word of mouth triggers a *certain interest*, which drives the user to direct active participation. Another trigger for interest can be the need of a break. For this to lead to participation, it is required that the user already knows the existence of the installation, and its facilitation for physical activity. The *need of a break* as a motivational factor is especially relevant for returning users. A potential demotivating factor that can lead to dropout is the immediate *lack of interest*. This can be the result of bad promotion or that the user has no interest in interacting with this type of installation.

2 *Passer-bys*

If the population transitions into the *passer-by* role, they are in visual proximity of the installation. They are then able to experience the potential *buzz of the installation* and the audience. If there is no one already using the installation,

the *lack of installation buzz* may discourage passer-bys from approaching, unless they are experienced players. Then the *availability* of the installation may encourage use. Passer-bys will also be able to start *decoding* the functionality and features of the installation, starting a learning process. This can trigger an immediate *certain interest* that motivates direct participation, or a *curiosity*, a wish to investigate the installation further, that leads them to become bystanders or audience members. The location (including the existence of an audience) can be a demotivating factor leading to dropout, yet the user can still move on to become both a bystander or audience without being affected by it. A *long waiting line* or *bad timing* can also lead to dropout, but may leave the user more likely to return to the installation at a later time.

3 *Bystanders*

When becoming a *bystander* the user is actively observing the installation activity, but does not engage in the social interaction of the audience. This lets them continue *decoding* the installation features and be *entertained* by watching others perform the activity. The user still feels comfortable in the situation, regarding the *location*, but has not yet decided whether to participate. Here, too, *bad timing* or a *long waiting line* can be demotivating factors. If the user wishes to *engage in social interaction* with other observers, they can join the audience.

4 *Audience*

The *audience* is the people closest to the installation, except the players. They can closely observe player tactics and the installation feedback, and they can *communicate* with the players. The close proximity gives the audience the greatest *entertainment* value of the non-player user roles. Within the audience group, peer learning is likely to happen. This includes discussion of installation features, game approaches and tactics. As the audience may obtain a greater overview of the installation features, e.g. the visual feedback, than the players themselves, the audience can offer helpful tips to the players. The (humorous) communication with the players can further help the audience in understanding the difficulty level and if the activity is fun. In this learning process the audience members' expectations can be met, leading them to *commit to the activity* themselves or their expectations can be proven false, which will lead to *disappointment* and eventually dropout. At this point the user can also have

evaluated the location or the audience as too *intimidating* and feel *discouraged* and leave. *Withdrawal* can even happen after the commitment to the activity. This can be caused by a lack of an opponent to play against, or a stranger as the only, undesirable option for the two-player game. Any of the aforementioned demotivating factors can also still be reasons for dropout.

5 *Player(s)*

When entering the *player* role, most interactions are directed toward the installation or the opponent (if two-player mode). The opponent's actions and sayings can be both *confusing* and beneficial, as another opportunity for *peer learning*. The communication between players may result in a positive feeling of a *shared experience* with the installation. The installation itself can create events of *confusion*, as well as being the most important, obvious, source for *understanding installation features*. By testing and *adjusting tactics* in the game, the user can experience an ongoing learning process, where they learn from their own successes or mistakes. The user can also choose whether to take a *playful* approach to the installation, by being explorative and frivolous with no particular goal, or an approach mainly focused on game *rules*, where correct execution is the goal. Whatever the approach, users are motivated by the enjoyment due to a *competitive* setting, a *sense of accomplishment* or the *feeling of a satisfactory break*. The user leaves the player role when the game session is *completed*, or in some unfortunate events, because of *installation malfunction*. An unstable, frequently failing installation will have a demotivating effect on users, leaving them unsure if the installation will work properly at later occasions. *Individual challenges*, i.e. color blindness, or a too high level of difficulty or physical activity may also lead the player to *surrender* and drop out before completion.

6 *Dropout*

After completing the game, the user has the opportunity to return into any of the user roles. A motivation to become an audience member, can be the desire to *learn new tactics* or *watch peers* perform the activity. If the installation is available, players may also return directly to the player role, either to improve their execution of the game or for revenge on their opponent.

10.3 Lessons learned

In addition to the Playground Model, we learned some lessons related to the user experience that did not apply directly to the user journey. These lessons are explained below and paired with a guideline that should be considered by future designers and developers of public, playful installations.

Facilitate learning

The installation must facilitate learning, either through its implemented elements, through player-player or player-audience communication or through mere observation. Non-player users should have the option to learn before active participation. This learning process includes both system comprehension and game tactics and strategies. When it is easy to learn how the installation works, it leaves more time and mental capacity to focus on one's own efforts in the game.

> *Guideline 1. Facilitate learning, system comprehension and strategic development.*

Consider competitive elements

Competition stood out as the most important motivation, both regarding motivation to approach the installation, in game motivation and motivation for repetition. Giving users the opportunity of two game modes, where both competition against oneself and others was possible, proved to be valuable and appreciated.

> *Guideline 2. Consider competitive elements.*

Consider social surroundings

The social surroundings of the installation may greatly affect the users. The users may experience a fear of failure or in other ways feel discouraged from performing in front of others. In order to create the best possible installation experience for all users, the social surroundings of the installation should be considered.

Guideline 3. Consider social surroundings.

Consider the installation location

The location of the installation has, as presented in this thesis, a great influence on the users of the installation. When evaluating the location of an installation, several matters should be discussed: Does the location provide the desired amount of users? Is the location fit for the installation in question? Will the installation introduce challenges for the current use of the location?

Guideline 4. Consider the installation location.

Ensure installation robustness

In a realistic setting, the installation would not be staffed by facilitators that could make adjustments or make sure the installation was unharmed, and the installation would be operative more or less around the clock. This would place high demands on the robustness of the installation, both for its physical features and code. Users should be able to trust that the installation can endure their manipulations, thus installation robustness must be ensured.

Guideline 5. Ensure installation robustness.

10.4 Evaluation of research

Conclusion validity

Conclusion validity questions whether the conclusions reached about data relationships are reasonable.

The triangulation of data was made possible by the use of several methods. This allowed for stronger conclusions, as they were supported by various sources of data. In addition, conclusions are drawn based on the responses from 114 participants, after their experience with two different game modes. A strong conclusion validity is therefore suggested. The participants were all first-time users of the installation. This means that the findings of this study are not necessarily applicable to returning users of a similar system. This weakens the conclusion validity.

Internal validity

Internal validity questions whether the method used demonstrates a causal relationship between the variables or not.

All participants participated in the same test setup, where the majority of the variables of the test setup could be controlled. However, some variables were uncontrollable due to the study being conducted in the field. Technical implications with the installation may also have caused a slightly different experience for some participants. A limited internal validity is therefore suggested.

Construct validity

Construct validity questions whether the methods measure what they are intended to measure.

The study was conducted in the field, stimulating participants in their ordinary break setting in their everyday life. The factors discussed in this thesis are actual factors that were not created by the presence of the research team. A high construct validity is suggested.

External validity

External validity questions whether the relationship found can be generalized to other settings.

The conclusions are drawn based on the experiences of a sample consisting of 114 students. The sample, in terms of age and gender represent the target population well. In terms of setting, location, people and time, the data collection was conducted under realistic circumstances. All participants belonged to the same demographic group (students at NTNU), and their experiences are based on the use of only one installation. This suggests that the conclusions do not necessarily apply to all user groups or all public installations. A limited external validity is suggested.

Ecological validity

Ecological validity concerns whether the research is representative for what happens in the real world or in real-life situations.

Participants of the study might have been influenced by reporting to peers, exaggerating their positive responses. However, the conclusions are based on a triangulation of data sources of which one was anonymous. Also, the study was conducted in a setting (not in a lab), suggesting a high ecological validity.

Reliability

Reliability is the extent to which another researcher would find the same answer.

Most of the data was analyzed separately by two persons, preventing interpretation bias. Additionally, conclusions are based on a triangulation of methods and the study had a relatively large group of participants. This suggests high reliability.

Limitations

Based on the evaluation above, the overall validity of the study is high. However, it is limited by the narrow target population, weakening the external validity and making it harder to generalize. Also, the uncontrollable factors of the study field limited the internal validity.

Chapter 11
Conclusions

Conclusions

In this thesis, I have investigated factors that influence the users of playful, interactive installations in a public area, in order to answer the research question:

> *What factors, caused by social and physical surroundings, are present around the use of public, playful installations, and how do these influence the user's perception of the installation experience?*

The aim of the research has been to create a better understanding of the installation user journey. In order to conduct the study, an installation was developed, using an iterative user-centered double diamond design process. In this process, various solutions were ideated based on a set of requirements, before one concept was iteratively improved and evaluated.

Data about the users' experiences was collected using the following methods: interviews, observations, data logging and a questionnaire. The analysis of the collected data showed that the various circumstantial factors affected the users' willingness to engage with the installation, to make an effort in the game and to return for multiple game sessions. The main motivational factors to approach the installation were the availability of the installation, curiosity toward a new, unordinary and competitive concept and being entertained by watching the activity. A large audience and long waiting time were demotivating factors. When the user had committed to participate it became apparent that users valued different aspects of the installation experience, as some had a clearly playful, frivolous and carefree approach to the game, while others showed a desire to execute the activity correctly. Nonetheless, competition, a varied game and the demand for mental focus stood out as important motivating factors for the users to stay in the game. Confusion and individual challenges (e.g. color blindness) were demotivating factors. Users experienced a sense of accomplishment and an enjoyable level of physical activity and difficulty with the installation. This, as well as the possibility to develop strategies and try beating the high score, were the main motivating factors for repeated use. Throughout the user journey,

multiple events of learning were discovered. Learning was evident in the passer-bys' decoding of the installation, in the peer learning among audience members and between players and the installation elements.

These factors and their influence on users were linked to their occurrence in the user journey, and visualized in the Playground Model. The knowledge that has been uncovered in this thesis shows that every step of the user journey can and should be considered in the design process. Especially by being aware of activity dropout reasons, one can help users get through the *entire* user journey more smoothly and comfortably, giving them an overall better experience with the installation as a whole.

Additionally to the model, to help designers in future installation projects, a set of design guidelines were proposed. The guidelines are as follows:

> *Guideline 1. Facilitate learning, system comprehension and strategic development.*
>
> *Guideline 2. Consider competitive elements.*
>
> *Guideline 3. Consider social surroundings.*
>
> *Guideline 4. Consider the installation location.*
>
> *Guideline 5. Ensure installation robustness.*

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Appendices

Appendix A: Modified SUS form.

	Strongly disagree 1	2	3	4	Strongly agree 5
1. I think that I would like to use this game frequently	☐	☐	☐	☐	☐
2. I found this game unnecessarily complex	☐	☐	☐	☐	☐
3. I thought this game was easy to use	☐	☐	☐	☐	☐
4. I think that I would need assistance to be able to use this game	☐	☐	☐	☐	☐
5. I found the various functions in this game were well integrated	☐	☐	☐	☐	☐
6. I thought there was too much inconsistency in this game	☐	☐	☐	☐	☐
7. I would imagine that most people would learn to use this game very quickly	☐	☐	☐	☐	☐
8. I found this game very cumbersome/awkward to use	☐	☐	☐	☐	☐
9. I felt very confident using this game	☐	☐	☐	☐	☐
10. I needed to learn a lot of things before I could get going with this game	☐	☐	☐	☐	☐

Appendix B: Participant consent form.

Forespørsel om deltakelse i forskningsprosjektet

«DigiPlay: Fysisk aktivitet gjennom lekne interaktive installasjoner»

Bakgrunn og formål
Formålet med prosjektet er å få tilbakemelding fra brukere (i hovedsak studenter) på en konkret interaktiv installasjon som har til hensikt å oppmuntre til spontan fysisk aktivitet.

Prosjektet er del av et mastergrads-prosjekt ved Institutt for datateknologi og informatikk og Institutt for interaksjonsdesign, NTNU. I studien vil vi ikke evaluere helsegevinst, men kun samle inn tilbakemeldinger fra friske brukere om deres bruksopplevelse av installasjonen, i tillegg til data om ulike måter/strategier å interagere med i installasjonen på.

Du er forespurt om å delta fordi du er i målgruppen.

Hva innebærer deltakelse i studien?
Hvis du velger å delta i prosjektet betyr det at du er med på en brukertest av installasjonen som innebærer både en utprøving og et etterfølgende intervju og spørreskjema.

Dine svar fra spørreskjemaet blir registrert på papir og senere elektronisk.

Vi ønsker å kunne gjøre videoopptak av utprøvingen av installasjonen og lydopptak av intervjuet.

Det er frivillig å delta
Det er frivillig å delta i prosjektet. Hvis du velger å delta, kan du når som helst trekke samtykke tilbake uten å oppgi noen grunn. Alle opplysninger om deg vil da bli anonymisert. Det vil ikke ha noen negative konsekvenser for deg hvis du ikke vil delta eller senere velger å trekke deg.

Hva skjer med informasjonen om deg?
Vi vil bare bruke opplysningene om deg til formålene vi har fortalt om i dette skrivet. Vi behandler opplysningene konfidensielt og i samsvar med personvernregelverket.

Det vil kun være forskere tilknyttet prosjektet som har tilgang til dataene, og ikke noen utover dette, f.eks. din arbeidsgiver.

Navnet og kontaktopplysningene dine vil vi erstatte med en kode som lagres på egen navneliste adskilt fra øvrige data. Datamaterialet (video og lydopptak) vil bli lagret på en forskningsserver på et innelåst rom.

Deltakere i prosjektet vil ikke kunne gjenkjennes i publikasjoner. Her publiseres kun anonymiserte data.

Hva skjer med opplysningene dine når vi avslutter forskningsprosjektet?
Prosjektet skal etter planen avsluttes 01.09.2021. Ved prosjektslutt vil datamaterialet bli anonymisert slik at du ikke kan gjenkjennes. Dette gjøres for etterprøvbarhet og eventuell senere forskning.

Studien er meldt til Personvernombudet for forskning, Norsk samfunnsvitenskapelig datatjeneste AS.

Dine rettigheter

Så lenge du kan identifiseres i datamaterialet, har du rett til:

- innsyn i hvilke personopplysninger som er registrert om deg,
- å få rettet personopplysninger om deg,
- få slettet personopplysninger om deg,
- få utlevert en kopi av dine personopplysninger (dataportabilitet), og
- å sende klage til personvernombudet eller Datatilsynet om behandlingen av dine personopplysninger.

Hva gir oss rett til å behandle personopplysninger om deg?
Vi behandler opplysninger om deg basert på ditt samtykke.

På oppdrag fra NTNU har NSD – Norsk senter for forskningsdata AS vurdert at behandlingen av personopplysninger i dette prosjektet er i samsvar med personvernregelverket. (Ref. Meldeskjema [FYLLES INN REFERANSENUMMER]).

Hvor kan jeg finne ut mer?
Hvis du har spørsmål til studien, eller ønsker å benytte deg av dine rettigheter til å trekke ditt samtykke, ta kontakt med:

- NTNU ved førsteamanuensis Yngve Dahl ved Institutt for datateknologi og informatikk (yngveda@ntnu.no, mob.: 905 27 892)
- Vårt personvernombud: Thomas Helgesen (thomas.helgesen@ntnu.no)
- NSD – Norsk senter for forskningsdata AS, på epost (personverntjenester@nsd.no) eller telefon: 55 58 21 17.

Med vennlig hilsen

Yngve Dahl (Prosjektansvarlig)

Samtykke til deltakelse i studien

Jeg har mottatt informasjon om studien, og er villig til å delta

---

(Signert av prosjektdeltaker, dato)

☐ ***Jeg samtykker til å delta i studiet.***
☐ ***Jeg samtykker til at personopplysninger kan publiseres/ lagres etter prosjektslutt.***

Appendix C: Observation forms

Dato: _____

Test nr:	
Player 1 ID:	
Player 2 ID:	

Player	**Attitude/mood** Player 1	Uninterested	☐	Insecure	☐	Little energy	☐	Curious	☐	Excited	☐	**Other:**	
	Attitude/mood Player 2	Uninterested	☐	Insecure	☐	Little energy	☐	Curious	☐	Excited	☐	**Other:**	
	Communication between players	Yes	☐	No	☐	**Topic:**							
	Laughter	Yes	☐	No	☐	**Why?**							
Movement	**Whole body movement**	Yes	☐	No	☐	**If No, how?**							
	Green buttons intentionally not pressed?	Yes	☐	No	☐								
	Game pole placement Player 1	OK	☐	Too high	☐	Too low	☐						
	Game pole placement Player 2	OK	☐	Too high	☐	Too low	☐						
	Jumping	Yes	☐	Sometimes	☐	No	☐						
	Squats	Yes	☐	Sometimes	☐	No	☐						
	Effort to reach difficult button combinations	Yes	☐	Sometimes	☐	No	☐						
System usability	**Game-related questions?**	Yes	☐	No	☐	**If Yes, what?**							
	Confusion?	Yes	☐	No	☐	**If Yes, what?**							
	Asks for explanation?	Yes	☐	No	☐	**If Yes, what?**							

Sluttkommentar: _____

Two-player mode form

One-player mode form

Dato: _____

Test nr:	
Player ID:	

Player	**Attitude/mood**	Uninterested	☐	Insecure	☐	Little energy	☐	Curious	☐	Excited	☐	**Other:**
	Laughter	Yes	☐	No	☐	**Why?**						
Movement	**Whole body movement**	Yes	☐	No	☐	**If No, how?**						
	Green buttons intentionally not pressed?	Yes	☐	No	☐							
	Game pole placement	OK	☐	Too high	☐	Too low	☐					
	Jumping	Yes	☐	Sometimes	☐	No	☐					
	Squats	Yes	☐	Sometimes	☐	No	☐					
	Effort to reach difficult button combinations	Yes	☐	Sometimes	☐	No	☐					
System usability	**Game-related questions?**	Yes	☐	No	☐	**If Yes, what?**						
	Confusion?	Yes	☐	No	☐	**If Yes, what?**						
	Asks for explanation?	Yes	☐	No	☐	**If Yes, what?**						

Sluttkommentar: _____

Appendix D: Interview guide

INTERVJU
Åpning: Dette er testobjekt # og har prøvd game mode single/competitive

1. **Inntrykk av spillet.** Kan du fortelle litt om førsteinntrykket ditt av spillet?
   Hva syns du om spillet etter å ha spilt det?
   Var det noen ting du likte spesielt godt ved spillet? Hva? Hvilken påvirkning?
   Var det noen ting du ikke likte så godt ved spillet? Hva? Hvilken påvirkning?

2. **Forståelse.** Hvordan syns du det gikk å forstå hvordan spillet fungerer?
   Var det noen spesielle elementer som bidro til at du forstod spillet?
   Var det noe som forvirret deg? Hvis forvirring - effekt på innsats/motivasjon?

3. **Erfaring.** Har du prøvd noe som ligner på dette før? Hva var det?
   I hvilken grad anser du deg selv som en leken person?
   Pleier du å spille bordtennis/foosball/biljard/shuffleboard/etc hvis muligheten byr seg?

4. **Følelser/Playfulness.** Da du kom hit i sta, før du spilte, hvordan følte du deg da? Hvordan var humøret?
   Hvordan følte du deg når du spilte?
   Kan du si noe om humøret ditt nå i etterkant?
   Bidro spillet til noen endring i humør (eller motivasjon for det du skal etterpå)? Hva kommer det av, tror du?

5. **Fysisk aktivitet.** Hva synes du om mengden bevegelse spillet ga deg?
   Kunne/burde det vært høyere krav om fysisk bevegelse?

6. **Motivasjon.** Da du kom hit i sta, fikk du lyst til å spille da du så installasjonen?
   Hva fikk deg til å ønske å spille?
   Når du kom i gang, hva var motiverende i spillet?
   Hva skal til for at du ville brukt denne i hverdagen?
   Evt hva kan gjøre at du ikke har lyst til å bruke den?

   (Hvis competitive)
7. **Samspill.** Hvilken verdi har det for deg å spille sammen med andre?
   Fulgte du mye med på hva den andre spilleren gjorde? Hadde det noen påvirkning på din innsats i spillet?
   Kjenner du personen du spilte mot? Hvis ja, hvordan tror du det ville vært å spille mot en fremmed?
   Tror du spillet kunne fungert som en type icebreaker for å gjøre det lettere å bli kjent med fremmede?

   (Hvis single)
   Score. Hva tenker du om score i denne typen spill? Var det et viktig element for deg? Hvorfor/hvorfor ikke?
   Tenkte du over scoren underveis i spillet?
   Hadde scoren noen påvirkning på motivasjonen din i spillet?

8. **Sosiale omgivelser.** Hvilke steder tenker du at denne typen installasjon er egnet for? I hvilke situasjoner ville det være naturlig for deg å oppsøke denne typen installasjon.
   Hvordan tror du kø/ventetid ville påvirket din motivasjon for å bruke spillet?
   Hvordan ville et eventuelt publikum påvirket hvordan du føler deg i spillsituasjonen?

Gi objektet en liten oppsummering av hva du har fått inntrykk av i løpet av intervjuet.

Appendix E: Questionnaire form

Dato:_____

Spørreundersøkelse om lekne installasjoner

Kjønn: Mann ☐
Kvinne ☐
Annet ☐

Alder:_____

Kryss av for hvorvidt du er helt uenig, litt enig, verken eller, litt enig eller helt enig i følgende påstander.

		Helt uenig	Litt uenig	Verken eller	Litt enig	Helt enig
1.	Jeg syns varigheten på spillet var for kort	☐	☐	☐	☐	☐
2.	Jeg syns intensiteten på spillet var for høy	☐	☐	☐	☐	☐
3.	Jeg syns vanskelighetsgraden på spillet var passelig	☐	☐	☐	☐	☐
4.	Jeg føler at jeg fikk brukt kroppen i spillet	☐	☐	☐	☐	☐
5.	Jeg ville kategorisert dette spillet som lek	☐	☐	☐	☐	☐
6.	Lydeffektene gjorde det lettere å forstå spillet	☐	☐	☐	☐	☐
7.	Lysene i spillet gjorde det lettere å forstå spillet	☐	☐	☐	☐	☐
8.	Jeg syns at spillet var gøy	☐	☐	☐	☐	☐
9.	Jeg ville anbefalt dette spillet til venner	☐	☐	☐	☐	☐

Kryss av for hvorvidt følgende aspekter bidro til din fornøyelse i spillet?

		Ingenting	Litt	En del	Mye	Svært mye
1.	Samarbeidet (hvis aktuelt)	☐	☐	☐	☐	☐
2.	Konkurransen (mot deg selv eller andre)	☐	☐	☐	☐	☐
3.	Lyden	☐	☐	☐	☐	☐
4.	Lyset	☐	☐	☐	☐	☐
5.	Bevegelsen av kroppen	☐	☐	☐	☐	☐
6.	Intensiteten	☐	☐	☐	☐	☐
7.	Kravet om konsentrasjon	☐	☐	☐	☐	☐
8.	At det er en aktivitet utenom det vanlige	☐	☐	☐	☐	☐

Appendix F: Complete interview transcript in Norwegian.

I: Supert! Hva syns du om det her?
T:Det var interessant. Eh. Det tester jo reaksjonsevnen, så det var utfordrende, spesielt når det begynte å komme flere og flere knapper. Eh. Hadde vært gøy å prøve igjen på et senere tidspunkt, bare for å se når.. når man vet litt mer hvordan det bygges opp, hvordan det blir da senere. Eh. Ja.
I: Var det noe du likte spesielt godt ved spillet? Noen spesielle elementer som stakk seg ut som positive?
T: Jeg syns det var bra at det var timer på selve knappene, fordi det hjalp ehm.. Og da var det plutselig: «Åja, shit, der holder jeg på å.. den holder på å dø» liksom, så da må jeg være kjappere på den enn den. Det var varierende tid på, når det kom to knapper, kunne det være varierende tid?
I: Hvis det kommer to samtidig, har de på en måte samme, men de får kortere og kortere tid utover i spillet.
T: Ja, sant. Og avstanden på de [søylene] har jo en del å si da. For hadde de vært nærmere hadde det vært lettere for å se, men de er akkurat langt nok fra hverandre til at det blir vanskelig å se også. Så det var utfordrende, faktisk.
I: Ja, på en god måte?
T: På en god måte! Det var gøy!
I: Var det noe du ikke likte så godt da?
T: Jeg tror knappene kunne vært litt bedre.
I: Litt?
T: Litt mer sensitive, fordi at jeg traff noen ganger, så var det sånn «Ah, nei, den gikk ikke». Ehm. Ellers var det ikke noe spesielt jeg tenkte på. Tror jeg.
I: Nei, så bra. Hvordan syns du det gikk å forstå hvordan selve spillet fungerer?
T: Veldig lett. Veldig greit å forstå, det er: trykk på knappene når den lyser grønt, ikke trykk på de røde.
I: Du fikk.. Fikk du en forklaring på starten?
T: Mm.
I: Hvordan ville det vært uten den forklaringen, tror du?
T: Jeg tror det kunne vært ganske intuitivt med tanke på at de lyser, og de teller ned. Dermed så kunne det vært intuitivt. Men, ja.
I: Det blir jo på en måte bare spekulasjoner, men..
T: Ja, men det er mest fordi at du trykker på en grønn knapp og ser at du det er tre prikker [liv-indikator] foran deg, så du skjønner at etter hvert at hvis du trykker feil eller en av de går ut, så ser du at et liv går opp.
I: Mhm. Var det noe som forvirret deg?
T: Det hadde vært greit hvis, altså nå fungerer ikke høyttalerne denne gangen, men

hvis det hadde vært sånn, først får du en knapp, så to knapper, så tre knapper, så fire knapper, følte jeg, eller det bygde seg opp sånn. Så hvis den hadde sagt ifra når den gikk opp en vanskelighetsgrad.
I: Ja, på en måte et tegn om ny level, eller..
T: Ja, for da skjønner du at «Å shit, nå må du være mer og mer på».
I: Ja, godt poeng. Har du prøvd noe som det her før?
T: Nei. Eller, jeg.. Kanskje, men det var mer sånn eh.. knapper på et bord, sånn.. som lyste. Men det var mye simplere.
I: Litt sånn Whack-a-mole-aktig?
T: Ja, litt mer sånn, ja.
I: Skjønner.
T:Det var ikke helt.. det var ikke så mye koordinasjon, for da var det bare seks knapper, tror jeg, sånn der, også skulle du trykke på de som lyste.
I: Hvor var det, eller hvilken..?
T: Sverige et sted, eller var det i Tyskland?
I: På et sånt type senter..?
T: Ja, på et vitensenteraktig greie.
I: Sånn til vanlig i pausen og sånn, oppsøker du ofte aktiviteter på campus? Eller hva bruker du pausene dine på, vanligvis?
T: Pausene går ofte til å gjøre noe, fordi man blir litt stillesittende, så jeg pleier som regel å gå meg en tur, fordi her er det jo egentlig ingenting som skjer. Når jeg hadde forelesninger i Kjelbygget, så tok jeg og gikk opp og spilte pingpong, for eksempel. Så ja, jeg oppsøker jo litt annet.
I: Hvis det er tilgjengelig?
T: Ja.
I: Ja, så bra. Hvordan var humøret ditt da du kom hit sta? Hvordan følte du deg?
T: Jeg er veldig happy i dag, så det var egentlig godt humør. Fin i formen.
I: Og nå etterpå?
T: Jeg føler meg.. har litt mer energi faktisk. Det er fint!
I: Tenker du at.. for å stille et ledende spørsmål: har det noe med spillet å gjøre?
T: Jeg tror det har noe med litt sånn mestringsfølelse i spillet. Når man får det til så blir det gøy. Også var det litt utfordrende, og når man liker litt utfordringer så blir det gøy, da.
I: Kult! Hva syns du om mengden fysisk bevegelse i spillet?
T: Det var veldig passe. For det var ikke sånn at man blir svett av det, men man får beveget hele kroppen litt.
I: Syns du det burde vært mer eller mindre [fysisk bevegelse]?
T: Jeg syns det var passe for meg, men jeg kan skjønne folk som er litt kortere, at de vil kanskje ha litt mindre, for eksempel. Fordi det er jo, det har jo med armlengden å gjøre, holdt jeg på å si...
I: Ja, ikke sant. Da du var i gang og spilte, hva var det som var, på en måte,

motiverende faktorer for å gjøre en innsats?
T: Eh.. Vinnerinstinktet.
I: Hva sa du?
T: Vinnerinstinktet.
I: Vinnerinstinktet, ja.
T: Nei, ehm. Når jeg begynte så var det egentlig mer sånn «Ey, trykk på knappen», så blir det bare at du kommer inn i den rytmen. Da bare går det av seg selv, på en måte.
I: Ja. Bare det å holde ut, på en måte?
T: Ja, bare å prøve... bare kjøre på «dette her greier du» liksom.
I: Ikke sant. Nice. Tror du du kunne brukt denne her i hverdagen, hvis du hadde den tilgjengelig på campus, for eksempel?
T: Hvis den hadde stått her, så kunne jeg brukt den, ja.
I: Hva var det som.. hva ville motivert deg til å bruke den da?
T: Slå meg selv eller slå vennene mine.
I: Ja? Laget high score-liste, liksom?
T: Ja, fordi da kunne man ha.. da kunne man liksom målt seg mot seg selv eller målt seg mot andre på... Ja, for eksempel, jeg spilte Tetris før. Så hver gang prøvde jeg alltid bare å slå min egen rekord, så til slutt så går jo ikke det, men jeg prøver jo fortsatt og én dag så går det jo. Det blir jo veldig sånn da.
I: Ja, kult! Fulgte du mye med på scoren din underveis?
T: Nei.
I: Nei, okay! Hvorfor ikke?
T: Fordi når det handler om koordinasjon og bare... trykke på mest mulig knapper, vil scoren.. Hvis du fokuserer på scoren så mister du tid.
I: Ja, ikke sant. Så en taktisk greie?
T: Ja, taktisk.
I: Antall liv da?
T: Nei.
I: Nei. Så du bare spilte til det stoppet?
T: Ja, fordi hvis man da ser på det, så kan det hende at man ikke får med seg knapper, eller ett eller annet, da mister man de uansett.
I: Ja, ikke sant. Nå var det jo ikke så mye publikum her. Tror du det ville hatt noen påvirkning på deg når du spilte hvis det var mange folk rundt?
T: Eh. Nei, det tror jeg faktisk ikke.
I: Ville det gjort noe med terskelen for å oppsøke spillet og sette i gang.
T: Kanskje. Men hvis det er mange rundt, er det nok mange som er i kø. Og hvis det er en lang kø, så gidder man jo liksom ikke. Da blir det sånn «Å, jeg må vente. Har jeg tid til det i denne pausen?». Da vil jeg heller gå og fylle vann, eller noe sånt.
I: Okay, så bra. Jeg har fått inntrykk av at du syns det her var ganske ålreit, og tusen takk for at du var med!

Appendix G: Quotes in Norwegian.

1. [I: Var det noe du likte spesielt godt ved spillet? Noen spesielle elementer som stakk seg ut som positive?
   T: Jeg syns det var bra at det var timer på selve knappene, fordi det hjalp ehm.. Og da var det plutselig: «Åja, shit, der holder jeg på å.. den holder på å dø» liksom, så da må jeg være kjappere på den enn den. Det var varierende tid på, når det kom to knapper, kunne det være varierende tid?
   I: Hvis det kommer to samtidig, har de på en måte samme, men de får kortere og kortere tid utover i spillet.
   T: Ja, sant. Og avstanden på de [søylene] har jo en del å si da. For hadde de vært nærmere hadde det vært lettere for å se, men de er akkurat langt nok fra hverandre til at det blir vanskelig å se også. Så det var utfordrende, faktisk.]
2. ["du sa at dere sto her da, så tenkte jeg at det er fin avveksling å prøve ut, så ja. Altså, jeg har sett det på instagram at dere har testa det før og.. Så morsomt ut!"]
3. ["Jeg hadde hørt noen andre hadde spilt det, og det hørtes gøy ut,"]
4. ["Jeg visste jo ikke hva jeg skulle forvente, men jeg har jo sett at folk litt har gjort det før"]
5. ["Jeg vet ikke om det gir så mye inntrykk"]
6. [Ja, jeg har prøvd noe lignende. [...] det lå på bordet og det var to [spillere] mot hverandre og så var det om å gjøre tappe på flest [knapper]. Det var sånn reaksjonsspill det og, da. Det var ikke likt, men noe lignende]
7. ["jeg satt egentlig og tenkte litt på det i stad – Vi burde hatt en sånn i hver etasje [på campus]"]
8. ["gjerne ikke et sted hvor man er veldig utsatt... altså at ikke alle kan se at du står og spiller."]
9. [det hadde gått helt greit for min del, det tror jeg. Jeg tror nok enkelte ville opplevd det som litt sjenerende, men jeg synes på en måte at det krever ikke så mye av deg at du føler at du driter deg ut eller at du på en måte er veldig på fremvisning da.]
10. ["Det tror jeg hadde gått helt fint! Kanskje jeg hadde fått ennå mer konkurranseinstinkt, for å prøve å vinne."]
11. ["Jeg så at de fleste, når ingen spilte allerede, bare gikk forbi og jeg tror kanskje jeg ville gjort det samme, i hvert fall hvis jeg ikke visste hva det var."]
12. ["man ser jo det at det er mange som har lyst til å prøve det i pausen. [...] Vi stod jo en gjeng der og alle venninnene mine var sånn 'Jeg har lyst til å prøve' så var jeg sånn 'Ja, gjør det da, gjør det!'"]

13. [“Det var nå bare et spill, det var bare å gjøre noe annet enn hverdagen.”]
14. [“Det er kanskje det at det er en fysisk lek da. Det er kanskje det at det skiller seg ut litt sånn, at det er litt annerledes.”]
15. [“På Stripa er det for eksempel den ping-ponggreia som er gøy, men jeg gidder ikke å gå bort dit bare for å spille ping-pong”]
16. [“Pausene går ofte til å gjøre noe, fordi man blir litt stillesittende, så jeg pleier som regel å gå meg en tur, fordi her er det jo egentlig ingenting som skjer.”]
17. [“Står dere her lenge? Kan jeg prøve senere?”]
18. [“Hva faen er det der?”]
19. [“Og ser det veldig sånn vel gjennomført ut, det ser litt proft ut på en måte da.”]
20. [“Kult design og det virka veldig ordentlig, da. Så syns jeg konseptet var veldig gøy.”]
21. [I: Hva var det som gjorde at du fikk lyst til å prøve?
    T: Det var bare for å se hva det var, konkurrere med kompisen min.
    I: Var det hovedmotivasjonen din eller var det noe annet som gjorde det motiverende?
    T: Nei, jeg tror det [konkurranse] var hovedmotivasjonen ja.]
22. [I: Var det noe spesielt som fikk deg til å ønske å spille?
    T: Det var motivasjonen for å slå motstanderen da. (Latter)]
23. [“Det så nå artig ut. Det var artig å se på i alle fall!”]
24. [“Ja, jeg hadde jo sett bittelitt på det da jeg stod ved siden av”]
25. [T: Nei, det er klart det hadde jo blitt mer press da. Jeg vet ikke, jeg synes ikke det er sånn sykt kult å spille foran hvis det hadde stått liksom 20-30 stykk i ring rundt og sett på. [...] Jeg er kanskje ikke helt typen som stikker nesa frem [...] Så det hadde jo påvirka lysten til å spille kanskje.
    I: I negativ grad eller?
    T: Ja, hvis det hadde vært veldig mye folk]
26. [Det kommer litt an på, hvis det er en veldig stor gjeng kan jeg nok sikkert føle litt ubehag rundt det, men hvis det er mer sånn normal mengde som det er her på skolen, tror jeg nok det hadde gått helt fint.]
27. [“Det var veldig gøy, altså. Sånt lite, raskt spill mellom to spillere.”]
28. [“Det er såpass kort at det var greit å starte uten at det tar for mye tid.”]
29. [“Hadde det vært veldig lang ventetid så hadde jeg nok gått og kommet tilbake igjen og sjekket senere,”][“når det er kø så, spiller på en måte ikke folk flere runder, det er jo bare dårlig gjort så da hadde det nok gått ganske kjapt. Så det hadde ikke gjort noe å vente litt.”]
30. [Den pep vel når man trykka på den [knappene], tror jeg. [...] Bare sånn at det på en måte var en bekreftelse på at du faktisk har trykka på de. At de [lysene] ikke bare forsvinner, for at da er det ikke så lett å få med seg om de faktisk forsvinner.]
31. [Nei, det kan hende at det [lydeffektene] kunne ha hatt det [påvirkning på meg i

spillet], men jeg vet ikke om den var lav eller om jeg bare sonet den ut eller hva det var, men jeg la egentlig ikke merke til om det var noe lyd der. [...] Nei, for jeg tror at lyd kan gjøre ting mer engasjerende, men her så var det i hvert fall ikke noe jeg tenkte på i det hele tatt.]

32. [Jeg la egentlig ikke så veldig mye merke til lyd, men jeg vil tro at lyd ville fått meg til å forstå at jeg mista liv da, men... Men jeg føler ikke at det hadde så veldig påvirkning på meg her nå.]
33. ["Var det noen spesielle elementer som bidro til at du forstod spillet?"]
34. [Altså, [...] det er jo et ganske enkelt konsept at der det lyser, skal du trykke på, liksom.]
35. [Lysene. Da forsto jeg hva jeg måtte gjøre.]
36. [Jeg syns det var bra at det var timer på selve knappene, fordi det hjalp [...] Og da var det plutselig: "Åja, shit, der holder jeg på å.. den holder på å dø" liksom, så da må jeg være kjappere på den enn den.]
37. [Jeg synes måten lysene funker på er veldig intuitivt. At du på en måte ser at den ene knappen lyser – trykk på knappen. Det kommer sånt start signal, og så lyser det en knapp, med countdown, og da er det veldig intuitivt. Trykk på denne og når det etterhvert kommer rød knapper – ikke trykk på rød, og den [rød knapp] er statisk, så det er på en måte, ja... Jeg synes det funker veldig bra]
38. [Det var greit, når det er fargekodet så er det lett å se, og det er jo stor kontrast på de, så lett å skjønne [...] hvilke du skal trykke på.]
39. [Det var jo ganske intuitivt å skjønne hvordan du skal trykke på grønne knapper og unngå de røde. Oppfyller de fleste sånne prinsipper for at det er ganske innlysende.]
40. ["Jeg kan ikke leke uten deg"]
41. ["Ja, jeg føler jeg er litt sånn barnslig så jeg kunne sikkert synes det hadde vært gøy å bare holde på med den [spillet]."]
42. [Det var kanskje forutsetningen... altså, tydeliggjøring av hva man skal, hva skal du trykke på og hvordan eventuelt. Vi ble jo informert om at vanskelighetsgraden ville øke, men at det kommer to [knapper] samtidig, for eksempel, det var ikke jeg klar for, liksom. [...] Klargjøring av regler, kanskje. At rød må du ikke trykke på. Kommer an på hva hensikten er med spillet. Om man skal måle hva man lærer underveis... det vet ikke jeg.]
43. ["[å spille sammen med andre] er jo hele poenget, hvis ikke kunne jeg sittet på telefonen, det er jo mye av vitsen til at jeg spilte."]
44. ["Det er jo morsomt, for da er man sammen om det. Det... felles opplevelse og kan le litt, hvis det forhåpentligvis..."]
45. [Ja, altså, når ikke jeg så hvor knappene var, så så jeg jo at hun bevegde seg til den siden, for eksempel, og da fulgte jeg på en måte litt etter, eller bare sånn refleks, hvis du fatter hva jeg mener.]
46. [Altså, da tror jeg ikke at jeg hadde kommet hit og funnet en random person,

akkurat, å spille mot."]
47. ["for det er jo ikke noe sånn personlig spill"]
48. ["Jeg har ikke noe behov for å konkurrere mot noen andre enn folk jeg kjenner."]
49. [jeg ville vinne, veldig enkelt!"]
50. ["Å slå hun jeg spilte mot."]
51. ["Det er jo konkurranseinstinktet da, sånn generelt, at man bare har lyst til å score mest mulig."]
52. ["Jeg ville jo prøve å gjøre det bedre til de andre knappene, så jeg kunne få tilbake poengene mine."]
53. ["jeg må bare ta av meg, jeg tar ikke lett på den konkurransen her."]
54. ["man får liksom brukt både kropp og sinn samtidig!"]
55. ["At man ble litt mere på, på en måte. Siden det lyste mer, så ble man litt mer på alerten."]
56. ["Man kjenner det pumper litt og blir litt mere årvåken."]
57. ["Jeg fattet ikke helt hva den gule og den rød knappen betydde."]
58. ["Åja, hæ? Skal vi trykke på to samtidig?"]
59. ["Nei, altså, in the heat of the moment så tenker du ikke over at det finnes minuspoeng, når du ikke har fått vite det på forhånd."]
60. ["Det var greit å ha en sånn introrunde hvor det ikke var noen røde knapper og sånt, bare for å komme litt i gang med spillet, så ja, det hjalp på å komme litt inn i spiriten."]
61. ["Det var veldig enkelt å forstå, egentlig. Følte jeg bare kunne begynne med én gang."]
62. ["Siden jeg var i aktivitet, så fikk jeg jo brukt energien, og så fikk jeg mer energi av å røre meg mer også. Så positiv innvirkning!"]
63. ["[Jeg var] trøtt, litt sliten, jeg var litt sånn 'åh, lang dag'. Jeg fikk en liten oppkvikker av å hoppe rundt, det høres kanskje litt teit ut å si, men ja, jeg gjorde det. Du blir litt sånn 'wooo'."]
64. ["Nå er jeg litt mer gira på å komme meg inn og lære noe faktisk."]
65. ["Du tenker ikke over at du bruker kroppen så mye, så litt etterpå så blir litt sånn 'Oi, jeg ble litt andpusten faktisk'."]
66. ["Det hadde ikke vært noe problem hvis det hadde krevd mer."]
67. ["men kanskje noen hadde ikke likt det"]
68. ["[Aktivitetsnivået var] passe! Sånn for eksempel mellom forelesninger, sånn man blir jo ikke svett, og det er jo fint."]
69. [da kunne man liksom målt seg mot seg selv eller målt seg mot andre på... Ja, for eksempel, jeg spilte Tetris før. Så hver gang prøvde jeg alltid bare å slå min egen rekord, så til slutt så går jo ikke det, men jeg prøver jo fortsatt og én dag så går det jo.]
70. [Kan han nå hundre?!"]
71. ["Satan!"]

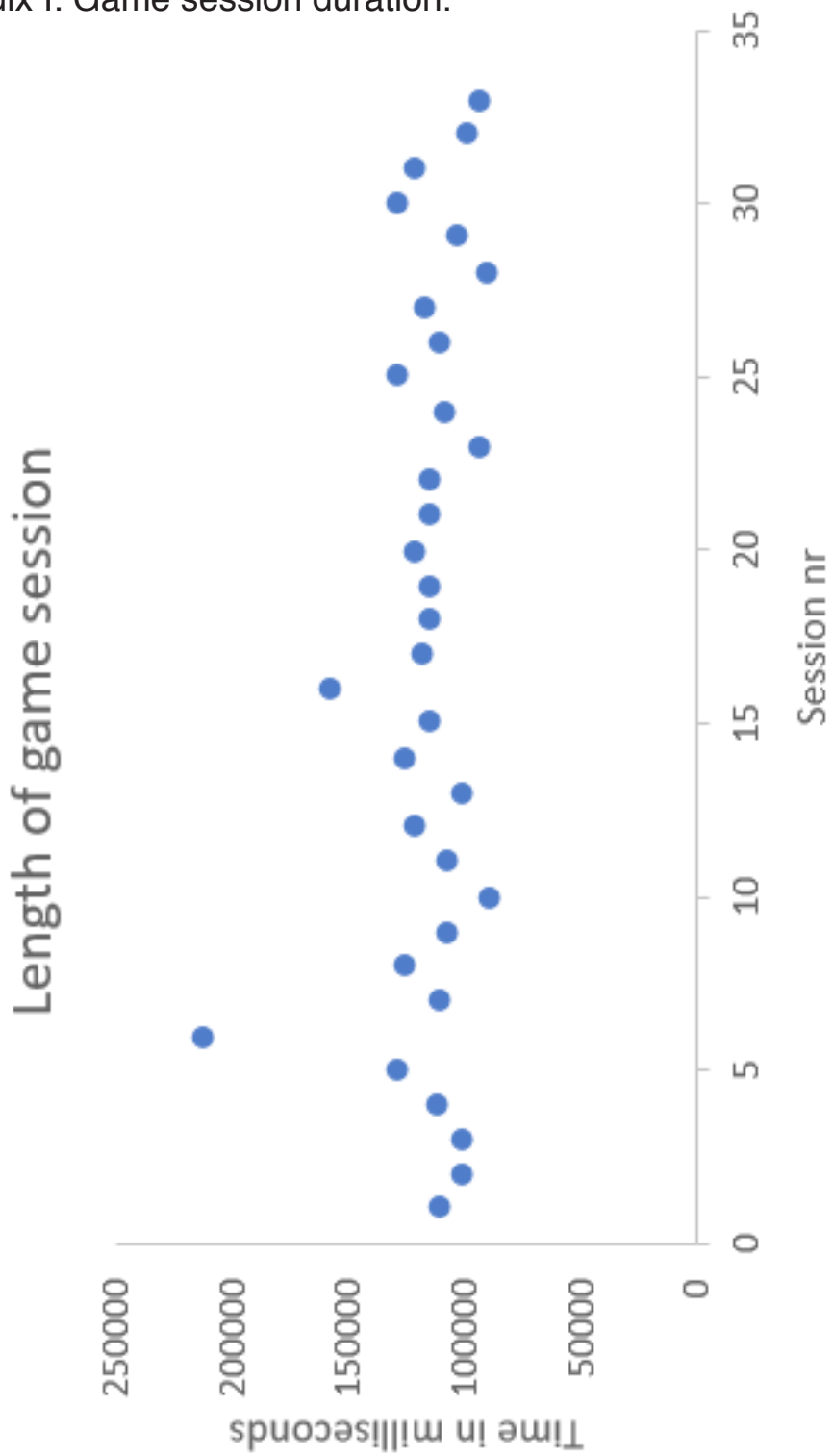
72. [“Faen! Er det mulig?”]
73. [kanskje at man kunne koblet det opp mot, du kunne for eksempel hatt en RFID scanner med studentkortet ditt og registrert brukeren din og fått opp navn og bilde og score, og så hatt det på en ukentlig basis kanskje koblet opp mot konkurranse eller et eller annet?]

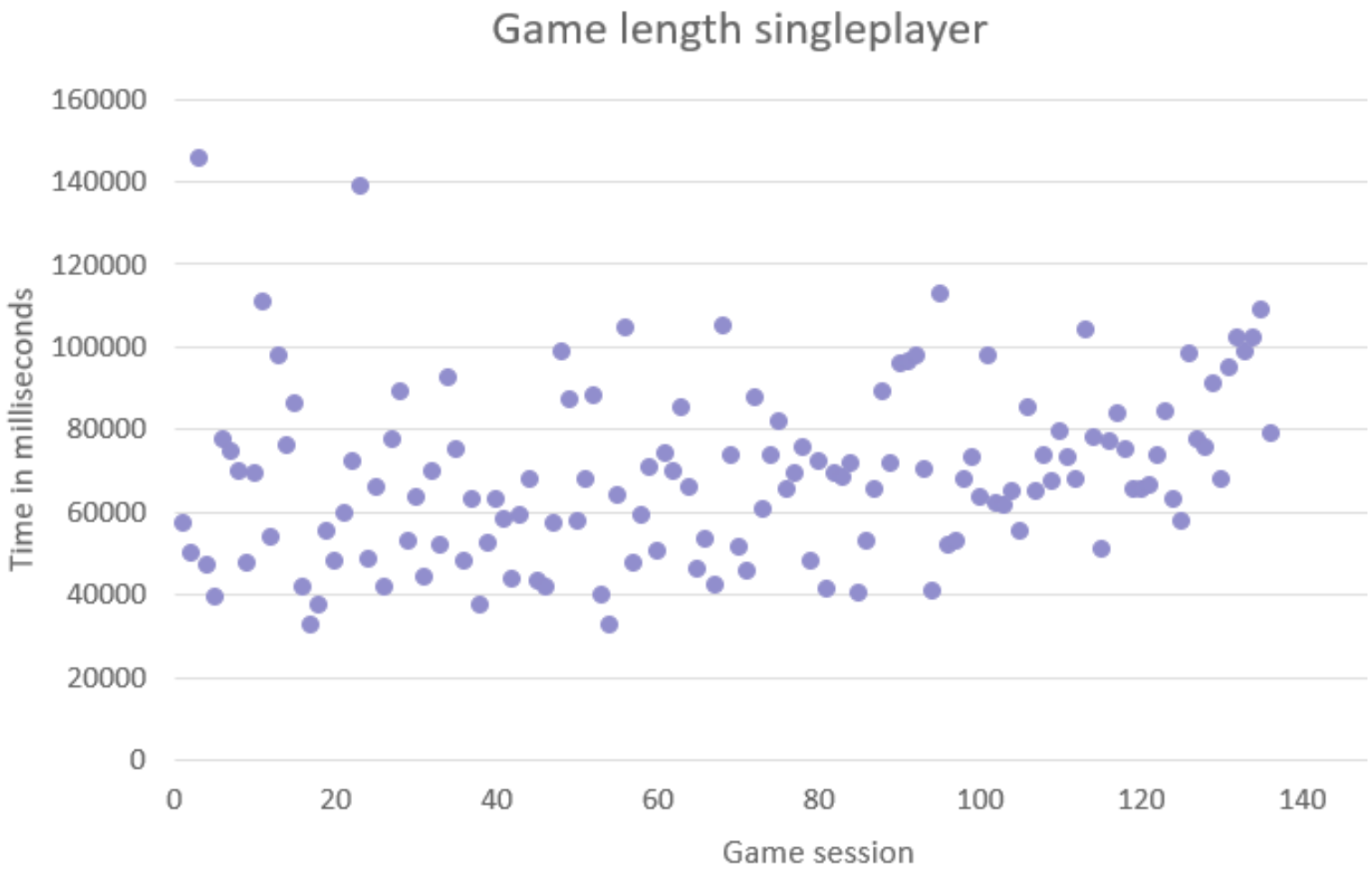
Appendix H: Students at campus Gløshaugen.

Excerpt of overview of students on campus Gløshaugen, by study program and gender. Via Jonas André Hansen, Academic Administrative Division, NTNU. Received May 13th, 2020.

M		**11754**	63,20 %	
K		**6853**	36,80 %	
Sum		18607	100 %	
ARAEVU	Arkitektur, etter- og videreutdanning		K	9
ARAEVU	Arkitektur, etter- og videreutdanning		M	12
ARDEVU	Oppdragsbasert videreutdanning innen arkitektur og design - høyere nivå		K	24
ARDEVU	Oppdragsbasert videreutdanning innen arkitektur og design - høyere nivå		M	19
BBI	Biologi - bachelorstudium		K	204
BBI	Biologi - bachelorstudium		M	74
BFY	Fysikk - bachelorstudium		K	36
BFY	Fysikk - bachelorstudium		M	131
BGEOL	Geologi - bachelorstudium		K	45
BGEOL	Geologi - bachelorstudium		M	37
BIELEKTRO	Bachelor i ingeniørfag, elektro		K	20
BIELEKTRO	Bachelor i ingeniørfag, elektro		M	145
BIFOREN	Bachelor i ingeniørfag, fornybar energi		K	24
BIFOREN	Bachelor i ingeniørfag, fornybar energi		M	44
BIT	Informatikk - bachelorstudium		K	115
BIT	Informatikk - bachelorstudium		M	424
BKJ	Kjemi - bachelorstudium		K	65
BKJ	Kjemi - bachelorstudium		M	77
BMAT	Matematiske fag - bachelorstudium		K	27
BMAT	Matematiske fag - bachelorstudium		M	112
BPOLØK	Politisk økonomi - bachelorstudium		K	4
BPOLØK	Politisk økonomi - bachelorstudium		M	14
BSØK	Samfunnsøkonomi - bachelorstudium		K	184
BSØK	Samfunnsøkonomi - bachelorstudium		M	292
EMNE/AD	Diverse studier - Fakultet for arkitektur og design		K	40
EMNE/AD	Diverse studier - Fakultet for arkitektur og design		M	27

Appendix I: Game session duration.




Game length singleplayer
160000
140000
120000
100000
80000
60000
40000
20000
0
Time in milliseconds
0
20
40
60
80
100
120
140
Game session