

Group 5

Let's Socialize Hybrid Chess!

*A design project that aims to enhance the social connectedness
of chess in a hybrid setting.*

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1. Introduction

Offline chess, like so many other face-to-face activities, took a hit during the 2020 pandemic, resulting in a surge of online and hybrid chess [29,30]. During this time, Netflix [31] also produced "the Queen's Gambit," a critically acclaimed series that won two Golden Globes, which attracted a large number of new players, both men and women, to the game [30]. This fact is demonstrated by the increase in searches for the terms "chess" and "how to play chess" (see *Figure 1*). Many people play online chess on for example chess.com [32] or live stream while playing via Twitch [33], which is how our group first became acquainted with this board game for our project.

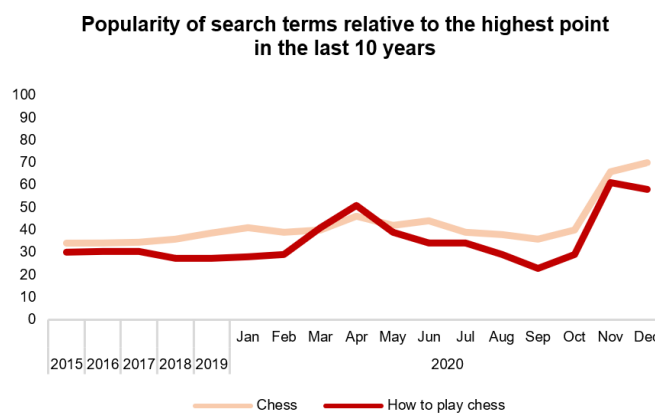


Figure 1 - Trend of search terms over the past years

2. Domain Analysis

When we started our initial research, we realized how chess could be played in different ways. Some games were played face to face, some with players situated in different locations, in an arena with multiple players and audience, some with commentators et cetera. In some chess Twitch channels, the host of the channel played rounds, while interacting with their online audience through chat, while some games were a third-person view of a chessboard where a camera was focusing on players, without any sound or interaction. We discovered that many of these chess rounds, regardless of skill level, were played without an arbiter (game judge). As a result, there was always the possibility that people would find a way to cheat. In the event of a pandemic, how does a highly strategic and competitive game like chess, without being co-located, deal with such a problem? Enter hybrid chess.

Hybrid Chess, as per International Chess Federation (FIDE) [13], is a chess game format in which the participants are physically present in a public location such as clubs or hotels, etc., and play chess with other players around the world via an online platform. All games are played

under the supervision of an arbiter present at the location [13]. Hybrid Chess has gained more popularity after the Covid-19 pandemic and is now one of the established ways of playing professional chess, FIDE has recently included a chapter on Hybrid Chess in their “*FIDE Online Chess Regulations*” [34].

2.1 Practitioners and elements involved in a Chess game

1. **Players:** In a typical chess round there are 2 players involved playing against each other using white and black pieces. In some cases, like an online game, a player can also play against a computer agent.
2. **Arbiters:** Professional and competitive chess usually involves an arbiter or a game judge who oversees the rounds and helps with dispute resolutions, decision making, and negotiation between the players in certain circumstances.
3. **Spectators:** Spectators can be present offline and in a remote setting to view a game. In an offline setting, players usually also spectate other games happening in the playing space and engage in social interaction with each other. In an online setting, people involved in spectating live streams, engage using a chat window or react to the game using emoticons.
4. **Chessboard and pieces:** A chessboard contains alternate white and black squares laid out in an 8x8 grid format. Each square has a unique name which is a combination of a letter (A→H) and a number (1→8). A chess game starts with one player having 16 white-colored pieces and the other one having 16 black-colored pieces. The board and pieces are usually made of materials like wood, plastic, sometimes glass, or even ivory. The person with white pieces always starts.
5. **Chess Clock:** A chess clock helps players track the time spent on their moves. It usually contains two clocks, one for each player and helps prevent game delays. In an online game, this is automatically tracked by the game engine.
6. **Chess Score Sheet:** A score sheet helps in keeping track of the moves made by a player. Typically a player will note down the moves made in the format of the *name of the piece and the unique name of the square*. Eg: Qh5 (Queen to H5). In an online game, this is automatically tracked by the game engine.
7. **Laptop:** A laptop is usually needed for online and hybrid modes of play. In an online setup, the chess game is played with a laptop. In a hybrid setup a laptop is more of assistance as it helps the player make his moves as well as see what move the opponent has made, for the player to perform the same move on their physical board.
8. **Camera & Microphone:** A camera and microphone are used to stream the chess game in an online and hybrid setup. It is usually used along with video conferencing or streaming platforms like Zoom [35] or Twitch.

In hybrid chess, the players might not sit in the same room, but rather next to a laptop connected to the internet, which serves as a connection to their opponent as shown in *Figure 2*. The arbiter's

job entails not only overseeing all chess moves but also inspecting the player's laptop to ensure that no illegal software is running [36].



Figure 2 - Players engaging in Hybrid Chess

There are some key differences in physical and social aspects when comparing online, offline and hybrid chess. In hybrid chess, the player uses a real chessboard, which can be stationed anywhere, the players need a laptop each, and they do not meet their opponents face-to-face. As a result, the standard game of chess, with all of its various embodied features, plays out extremely differently in other mediums [36]. Our group was particularly interested in how this influenced the game's social components.

2.2 Ethnographic Studies and Epoché Observation

Our domain ethnographic studies and epoché observations were in the form of offline, hybrid online observations as well as semi-structured interviews. We observed chess players who played offline games as well as hybrid and online games, which will be explained further in *section 4.2*. This helped us to get a better understanding of the social aspects of the game of chess. We started with online observations by watching Twitch [33] streams of online games, and videotapes of hybrid chess games viewed on YouTube [37]. We also observed a user who played an online game with his opponent who was co-located in the same environment, which made it into a hybrid setting.

Additionally, we observed a professional chess tournament in Uppsala with close to 25 players from different chess clubs in Sweden participating in an offline setting and playing chess face-to-face. We observed three rounds of games where we focused on observing specific

playing pairs, their interactions with artifacts and their opponents as well as what was happening in the environment around the players.

2.2.1 Results from observations and interviews

During the breaks of the physical chess tournament we got the opportunity to conduct three semi-structured interviews which gave rich information on players' thoughts and expectations. We asked them in-depth questions regarding the social connectedness aspects of chess (see *Appendix A*). These are the results from our initial epoché observations and from the three interviews we conducted for our domain analysis.

Epoché Observations

During our first epoché observations we observed a hybrid round of chess against two people. The players sat in the same room with their computers and played chess online but against each other. Here we saw that they both were concentrated on the chess round itself and only viewed their computer while making their moves, and when it wasn't their turn they sometimes looked at each other. Both of them used their computer trackpad/mouse when making their moves, and they would lean forward towards the screen when it was their turn. They would often discuss the moves that they had made, but otherwise, they were mostly quiet and focused on the game. After the game was finished we observed how they started discussing the round, and talking about certain moves and how they could have done them differently or if it was an unexpected move that was made.

During our second phase of observation, we observed different chess players that streamed on the platform Twitch. Here we observed another type of interaction of chess, where they played rounds online while talking to their viewers, communicating by answering questions via the chat function. In addition, they discussed their opponent's moves or they talked about something else while playing. The streamers played fast chess, also known as Blitz, and entertained their viewers by discussing how they could have played differently. They would talk during the round as well as after the round was complete.

The last set of epoché observations was made at a tournament in an offline setting where every player was present at the venue, which can be seen in *Figure 3*. Here we saw that before each game the players greeted each other, with a handshake, fist bump or they would just say hello before sitting down and starting their clocks. The arbiter walked around between the boards 1-2 times during each round and checked the boards. We noticed that the players did not talk during the rounds and made little to no sound and due to the silence we focused on observing the players' body language. Most players kept their eyes on the board, whereas some players would also look around the room or observe the boards next to them. Additionally, we noted that some players were shaking their legs and changing their body position several times during the game. When the round ended they would shake hands or fist bump with their opponent, and put the

pieces back to their original position. The players would then leave the room where the tournament was taking place to go to another room where they could eat sandwiches, drink coffee and talk to each other. In the “fikaroom” we observed how the players were talking to their opponent about the round and specific moves that had been made. Most players would then go back out and watch the remaining games.



Figure 3 - Observation environment from In-person chess tournament

During the epoché observations of the offline chess tournament, we spoke with some of the players in the form of semi-structured interviews.

Interview 1

In the first interview the participant mentioned that the main difference between playing physical chess compared to a hybrid setting, was the absence of not being able to view your opponent or that you can experience the opponent's happiness or frustration, you don't get to experience that much emotions when playing online. Chess turns more serious when playing offline, like the feeling of touching real pieces. What's lacking when playing online is a good space that is soundproof, has good lighting, professional organizers and incorporates the social aspect of playing chess. The physical environment was therefore an important aspect for this player. The interviewee further stated that areas for improvement in online chess are to be able to view your opponent and that you aren't able to choose the sound or light of the space.

Interview 2

In the second interview it was mentioned that the biggest difference is the board and not being able to see or read your opponent's emotions, you aren't able to see where your opponent is

looking, their gestures, facial expression and body language. According to the interviewee, it is also easier to make a mistake in online chess, since you could easily slip with your mouse and drop the piece at the wrong place. The physical aspect that the interviewee believed was missing in hybrid chess was being able to touch the pieces, talking and discussing with other people. A difference, mentioned by the participant, between physical and hybrid chess was the ability to walk around in the room to observe other games. The social aspects that the interviewee was missing in hybrid chess was the feeling of being part of a community and getting the time to analyze the round, however some clubs do it together after a tournament.

Interview 3

When playing offline chess interviewee three usually talks to the opponents after the game and conducts the reflection in an adjacent room, when playing chess hybrid you lose the possibility to interact with people before a round and also the social aspect in reflecting afterwards. The interviewee stated that it didn't feel like you played chess in a hybrid setting today, since you weren't able to see the person you played against. When seeing your opponent it becomes more serious and you can see if he or she is a nice person. This player found the social aspect of chess to be important and stated that for many chess players the social aspects are more important than the actual game. Under a classic chess round (where they have a longer time to contemplate their moves) the round turns more personal, which you would lose in a hybrid setting according to this player. When playing online it was stated that the person wouldn't use a function to make conversations afterward, since they would only play online for the game and not the social aspect of it.

2.3 Analysis

2.3.1 Social aspects of chess

The social aspects of chess that were based on the domain analysis included visually seeing the opponent's facial gestures and body language. During the observations at the chess tournament, there was a common behavior among the players which was to discuss their previous round and ask other players how their rounds went. This part of chess was highly appreciated by the interviewees since they believe it is an important element of their whole chess experience. Participants stated that the social aspect of meeting other players is important and for some even more important than the actual game of chess.

2.3.2 Physical aspects of chess

Based on the interviews and observation we found a range of the physical aspects that were connected to chess. For one interviewee a good space, where it's soundproofed and has good lighting was an important factor. One physical aspect that was important to another interviewee was the ability to touch the chess pieces as they used them to fidget with. Another aspect that

was brought up was the ability to physically walk around and observe other players' chess rounds.

2.4 Design opportunities

After researching the domain of hybrid chess we identified some opportunities or places for improvements concerning embodied aspects. A few opportunities which we discovered are:

1. The cooperative chess talk or reflection after the game, between the two players. This works well offline but it is not as simple in a hybrid way.
2. The difference in way of tracking their moves using a scoresheet. This is very often done offline to track and analyze the moves in certain formats of a chess game, but using an online platform makes this happen automatically reducing the physical effort made by the player.
3. Studying physical and mental stress factors differing between offline and hybrid play.
4. Effect of the arbiter on the game and players.
5. The difference in social pressure while playing a chess game offline and hybrid way.

Out of all these, we identified one potential design opportunity which we can focus on in terms of improving social connectedness through our chosen practice: **Post-round cooperative interaction between the players reflecting on their played game**. This was expressed as an important aspect by the players we interviewed and they expressed this was simple to perform in a face-to-face game but more difficult and ineffective in a hybrid situation. Therefore, our goal is to improve the social interaction between the players, focusing more on the post-game co-op discussion.

3. Background & Theory

The topic that we are exploring will be analyzed using different theories of embodied interaction. The theories are divided into seven sections; perception in chess, social connectedness in a hybrid setting, physical interaction, conversation in board games, AI-based question generation to engage in social conversation, and materiality.

3.1 Perception in chess

When it comes to perceptual imagination, chess is very similar to any other physical sport [5]. The tactics and strategies executed by a chess player involve imagination based on the spatial possibilities over the chessboard. This might be similar to how a ball game player looks around, finds opportunities on the field and makes the pass. Pieces on the board play an important role in how a chess player thinks. Professional players start playing the game with the best set of moves which they arrive at mostly based on their intuition. They also memorize piece grouping to see

the next best possible outcome from the piece positions. The intuition coupled with the pattern recognition of the aid of the piece to a chess player's decision-making [5].

To understand and identify a potential move, many chess players talk about having a good “sight” of the board and the pieces. The need to see a piece comes with the ability to understand what that piece can do, as well as to utilize its function [5]. These perceptual thoughts of a player are guided based on the visual awareness of qualities that arises from the position of the pieces on the board. For a good chess player, it feels as if the pieces on the board are alive and the positions of the pieces that they can see always has a meaningful presence as well as creating a strong emotional resonance [5].

3.2 Social Connectedness in hybrid settings

People's social practices play an important role in an offline setting, where the social aspect is an important function for the enjoyment of a board game. From previous research in gaming, it has been found that social capital grows from playing with friends offline and playing with strangers online [27].

Furthermore, one study shows that playing a board game via the internet is not the same as playing it in person. The responding participants in Heshmat & Neustaedter [2021] plainly state that the social connection they felt online during Covid-19 was significantly weaker than when they were physically engaged with each other.

In an offline setting when playing board games, the space of the board game plays an important role. The board game requires people to gather around the space and interact with each other. Moving towards an online environment and the board game becomes non-physical, however, people wanted as much of the real experience as possible. Even though the online setting is similar to the offline playing of a board game, the physical aspect and the pleasure of playing board games were lost. The core of the board games is the feeling of rolling a dice or moving chess pieces was lost when playing online [27].

Social interaction in the form of verbal and non-verbal communication is a big part of board games, the researchers found that when playing online people set up their own ways of communicating. Seeing your opponent's body language, and gestures and having eye contact helps players create a mutual understanding of the game and analyze their opponents [27].

Social interaction in hybrid settings in a general sense has also been researched, stating that in a traditional video call there is a focus on the conversational and focus on play and care is lacking [26]. Therefore, only using a traditional video conferencing system in a hybrid setting will not allow for extended social interaction.

An element that we wanted to investigate concerning social connectedness was the use of lights. In a study by Tollmar and Persson [2002] they explore how technology can be used to support intimacy at distance [21]. In this study, they showed how lights were used in homes to indicate to neighbors as well as other family members that you are at home. The use of lights in their example are used to show presence and communicate with the surrounding remotely without text and speech. In another study by Visser et al. [2011] they created the SnowGlobe with the purpose of creating “interpersonal awareness of movement between people in two remote living rooms” [22:1]. The SnowGlobe is a lamp that lights up when it senses movement, meaning that the other person will be aware when someone is moving in another room. After testing this with participants they found that the SnowGlobe enhanced the social connectedness, by creating awareness of the other person’s presence. Additionally, the participants believed that the lamp increases the quality of contact with the other person [23].

3.3 Physical Interaction

From the previous observations in *section 2.2*, we found that players end the game by either shaking hands, or with a fist bump. We aim to replicate this gesture in our design as it is an element in the social connectedness aspect of the game.

Sportsmanship Gestures

A handshake is a ubiquitous form of physical interaction in sports, especially during the end-of-game ritual in sports [11]. The handshake is an action that presents a request to the opposing person and it is up to the second person to accept the request with an offering. The handshake is a social gesture that communicates information between the persons and that follows the norms of that specific context. A handshake is often associated with good sportsmanship in sports and Hamilton [2017] connects it to the concept of haptic economy. Haptic economy is defined as what is permitted in a specific context when it comes to physical and haptic interaction [11]. During a chess tournament, there are specific social and behavioral rules that are set for the players called the conduct of the players [36], which are based on respect for everyone involved. Respect is a foundational pillar in chess and a way to show this respect is through a handshake at the beginning and at the end of each round [15], even though handshaking is not specifically mentioned in the handbook created by the federation of chess [13]. Therefore, exploring the handshake in a hybrid setting is of importance in this project.

Haptic feedback/Remote physical interaction

Developing tactile feedback-based multimodal emotional communication systems, according to Ahmed et al. [2016], should make you consider the relevance of two things. The visual emotional setting is the first consideration. This implies that, depending on the emotional state of the two persons involved, touching someone might signify very different things. When you are furious, the same touch might be viewed completely differently than when you are joyful. Second, consider how the specific technology employed in haptics could affect the emotional

information that can be given. Is one material superior to another, and how should we approach haptics for certain emotions [2]? The authors utilize a motor-driven elastic band in their force feedback system as an example. Other technologies did not feel right for their multimodal emotional communication, but this technology did. As a result, the research participants felt more emotive impacts and co-presence.

Similarly, according to Reed et al. [2011], haptic technology has the potential to be strong in transmitting certain emotions such as anger, disgust, and fear. We should strive to use various technologies to develop sentiments of sportsmanship and kinship in order to achieve these specific emotional goals.

Virtual Interpersonal Touch (VIT)

In an article by Bailenson et al. [2007], they mention that there is a major limitation to the virtual environment, which is that it lacks emotional warmth and nonverbal intimacy [3]. Bailenson et al. [2007] highlight the concept of virtual interpersonal touch, which creates a connection between virtual environments and physical touch. VIT has shown to change the interaction between participants in regards to performance in the task and the subjective emotional connection to the other participant. Using VITs can enable behaviors that cannot typically exist in a virtual environment [3].

3.4 Conversations in board games

In the article *Chess as a Conversation: Artefact-Based Communication in Online Competitive Board Games*, McEwan and Gutwin's [2016] studied the retrospective analysis of the players who tried to understand and interact with the moves made in a board game. They identified four layers of interaction: the physical layer, syntactic layer, strategic layer, and personality layer. Verbal conversations have some similarities and differences but still contribute to great communication between the players. They found that simple but highly constrained games like chess can help engage in a rich and detailed conversation between the players [16].

3.5 AI-based question generation to engage in social conversation

One of our users expressed the need for some suggestive questions to be displayed that can promote and engage the players in a conversation. The most appropriate discussion subjects for a dynamic game of chess would alter from one game to the next. As a result, the questions should be produced in real-time using AI so that each game of chess has its own set of problems. Generating fitting discussion topics has been tried, with good success, in Kuthy & Meurers [2020] and Adamson et al. [2013], which makes us believe it would be a good fit for this project as well [1,7].

3.6 Materiality

In an article by Rogerson et al. [2016] they analyzed the importance of materiality in board games and how it influences the players' experience. The authors presented four domains of materiality, however only three of these will be discussed; the game board & components, and the immediate play environment.

It was found that the participants "emphasized the importance of board games' material components." [18:3959]. This element is considered important because the game's components signify "the theme, rules and potential actions" [18:3959]. This could be related to the chess pieces and the physical feeling of holding the pieces and moving them around, which is lost when playing chess online.

To further enhance the social learning environment of the chess game post-reflection, the players should be able to see and hear each other. This is not possible in a typical online or hybrid game of chess. To add this functionality would be in line with Tyrer's [2021] findings, which showed that visual and audible feedback improved learning between people [22].

When merging physical (such as a chessboard) and digital (such as screen components) materials, we should aim to avoid making clear distinctions between them. Just like in Giaccardi & Karana [2015], we should try to use the combination of the material properties to "unfold and transform social and cultural practices" within our chess context [10:2454].

3.7 Space and place

The concept of space and place are different concepts that should be separated, both the concepts are aspects of spatially organized environments [9]. Space describes the dimensions of the measurable aspects of a room or similar that can facilitate various movements and interactions, while place is the social and cultural meaning of a setting. Dourish identifies them with the catch-phrase "space is the opportunity; place is the (understood) reality" [9:299]. Dourish [2006] further explains that space is pre-given and place as a social output.

Hornecker [2005] explains place as inhabited space and the structural aspects of space turn into spatiality, the measurable will become a purposeful space. The structural relations are important since the spatiality will determine how the interactions will unfold. When using space the people give it meaning due to, for example, the events taking place. Already from the start, just by looking at the outside of a space will generate meaning and expectations on what's to come. Real places, where a hybrid chess tournament takes place for example, have a certain atmosphere to it where a certain social interaction plays out. As well as certain aesthetics and physical factors that are necessary to accomplish the appropriate place and space [12].

4. Methodology & Methods

4.1 Methodology

This project will focus on knowledge generation from a pragmatic perspective, which Feilzer [2010] explains to be the focus on how the user generates their knowledge through experiences as well as the physicality of the human body [28]. In terms of phenomenology, we focus on individual experiences from users and base that information on design decisions in addition to existing and relevant research connected to the domain of hybrid chess. When conducting ethnography, phenomenology guides research of the relationship between the physical, social and cultural aspects. This phenomenological study will use different frameworks and methods to enable retrieval and evaluation of data and evaluation of designs.

Since this project focuses on aspects of how humans interact in social situations, using a user-centered and participatory design methodology enables a way to cooperatively make design decisions based on real-life user interactions and experiences. Simonsen and Robertson [2012] mention that participatory decision-making ultimately provides users with products that are fit for them, satisfying their needs. The authors present participatory design as where the designer aims to understand and learn as much as possible about the user's reality, in parallel with the user who aims to present their desired ways of solving the problem at hand [19].

The double diamond is a way of visually presenting the various stages of a design process [20]. Stickdorn et al. [2018] describe the double diamond process which includes the stages: discover, define, develop and deliver, where each stage is either divergent or convergent. Divergent refers to expanding perspectives and being open to a wide range of possibilities, which is done during the discovery and development stages. Convergent refers to constricting perspectives and choosing specific options based on design decisions, which can be seen in the define and deliver stages.

Stickdorn et al. [2018] presents not only the double diamond as a way to structure a design project but more specifically include the chapters Research, Ideation, Prototyping and Implementation to help designers structure different stages of design projects [20].

An aspect that is missing from this framework is an additional diamond structure focusing on research, finding a domain area, and finalizing a domain topic. Therefore, the figure below (*Figure 4*) portrays a more specific representation of the study, which will be referred to as the triple diamond design process.

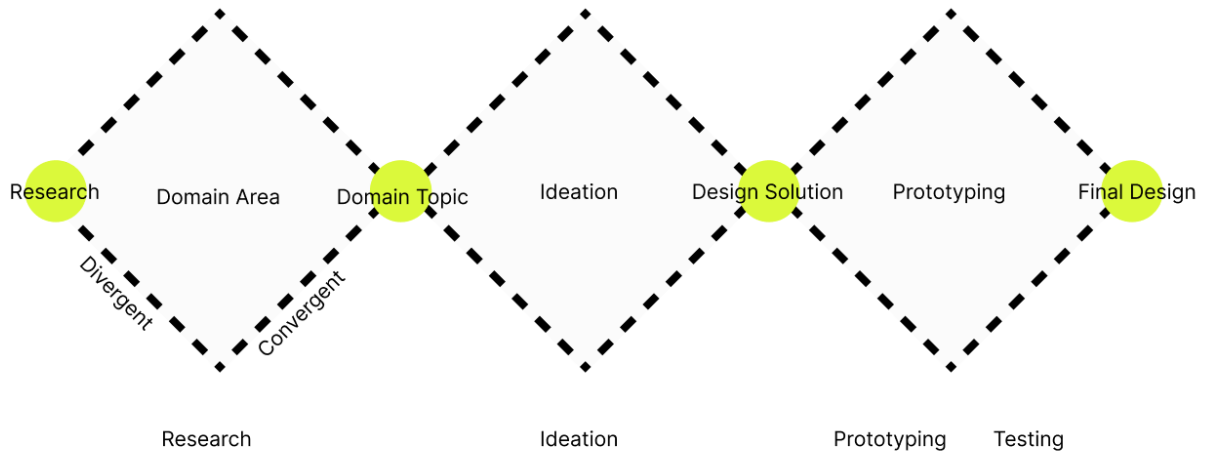


Figure 4: Visual representation of the triple diamond design process.

4.2 Method in Domain Analysis: Observations and Interviews

Hybrid chess game

One of the first epoché observations we conducted was a hybrid chess game between two amateur players, as seen in *section 2.2*. In this case, we reached out to people in our social circle that have experience with chess in a hybrid setting, we made a convenience sample selection for this observation. We asked for verbal consent to observe and audio record the observation, and the players' identity and data that could be traced back to them was anonymized. Both players were located in the same room, however, they were using their laptops to play against each other on an online chess platform.

Observations regarding physical and social interactions with the laptop as well as the opponent were carried out. We observed what they did during the round, as well as what they said to each other. Three observers took notes on these aspects from different angles. After the chess game was finished, a short semi-structured interview with the players was conducted where questions regarding physical and social interactions were asked (see *Appendix 2*). Here one person was the interview leader, but everyone could ask follow-up questions. This was also recorded and later analyzed.

Hybrid chess streams & Online chess streams

In order to gain further input about what social and physical aspects of chess there are, additional epoché observations of chess were done through online streams where hybrid and online chess games can be observed. These were conducted through the streaming platform Twitch, where we searched for different chess streamers. Similar to the in-person observations, the observers focused on the physical and social interaction between the player(s) and their chessboard/device

that they were playing on. We did not record anything, we only took notes on their behavior. As well as how they interacted with the people that were watching them and interacting with each other through the chat function.

In contrast to the in-person observation, the players were unavailable for interviews since we were anonymous observers. We did not interact with anyone in the chat or the streamer itself, therefore we did not ask for consent to observe. Even though the participants will be anonymous in the observation notes it limits the level of ethics in the project.

Physical chess competition

We got the chance to participate in and observe a professional physical chess competition in Uppsala. We had reached out to this chess club via email in advance to gain initial consent to do observations. This was an opportunity to obtain on-site data, observe social interactions, interview domain experts, and get ideas that we had not considered before. The individual we made contact with at the chess club became our gateway into the community, which has been demonstrated to be a useful approach to alleviate the feeling of being strangers in a new study environment, by exposing us to other members of the community [8]. These epoché observations helped us gain more data to do a comparison between how you play hybrid chess and offline chess. Furthermore, observing our research subjects will improve the quality of the rest of our data by allowing us to make better interpretations [8].

Our five-person group divided responsibilities, with some of us observing merely the tournament hall, its social and physical features, and how the tournament games were played from afar. Here we only conducted note-taking of their behavior. A number of our members spent more time in the lunchroom, seeking opportunities for interaction between games, post-game reflection, as well as invitations to more intimate interviews. This was a strategic choice that increased our chances of valuable observations [8]. Here we mostly observed and if the chess players approached we would ask un-scripted questions mainly regarding hybrid chess and the comparison between the two.

The interview setup was the following: two group members where one was the interviewer and one note-taker, and one interviewee from the chess tournament. Before the interview started they signed a consent form (see *Appendix 3*). We audio-recorded the interviews and took notes. We asked open questions about the player and his/her thoughts on different facets or features of chess during these semi-structured interviews, which lasted around 15 minutes.

4.3 Ideation Methods

Bodystorming

We conducted a bodystorming session with participants from the Embodied Interaction course, following some of the teachings of *Understanding contexts by being there: case studies in*

bodystorming [17]. This workshop was more solution-oriented, as we had already gained sufficient data for the understanding of our domain from the previous observations. In order to create a hybrid setting during the bodystorming session, we placed a table and chairs back to back. On every table, there was a printed chessboard and three real chess pieces. Additionally, every table had six different props which were also printed images and these were VR, AR, speaker/microphone, lights, laptop, and camera. The participants were then randomly paired up and asked to be seated. The session was divided up into three sections, where we presented the participants with three different scenarios. However, all three scenarios had the same task which was to explain to each other where their pieces were placed on the board with the help of the props.

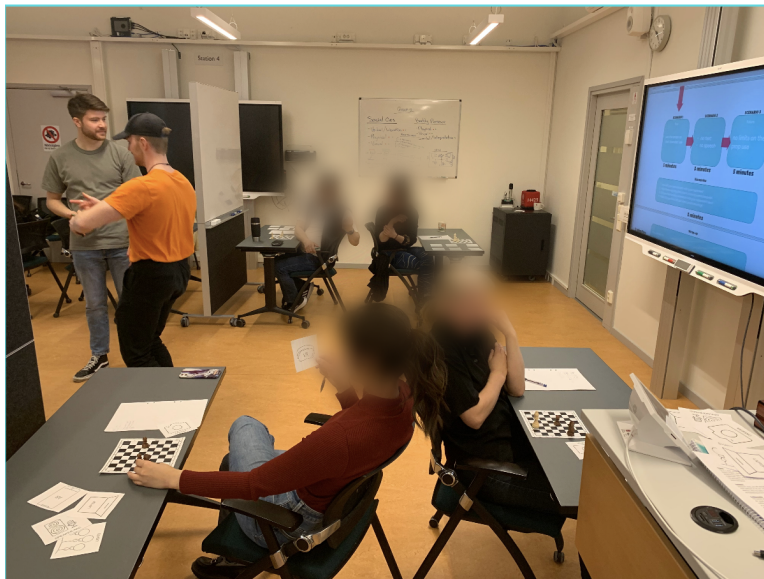


Figure 5: Bodystorming session

Scenario 1: Here, the participants were told to communicate with each other using the props as their intended use.

Scenario 2: In this scenario the participants were not allowed to use text or speech when communicating. They were still allowed to use the props as their intended use.

Scenario 3: Here, the participants could use the props however they wanted. For example, the lights could represent something else.

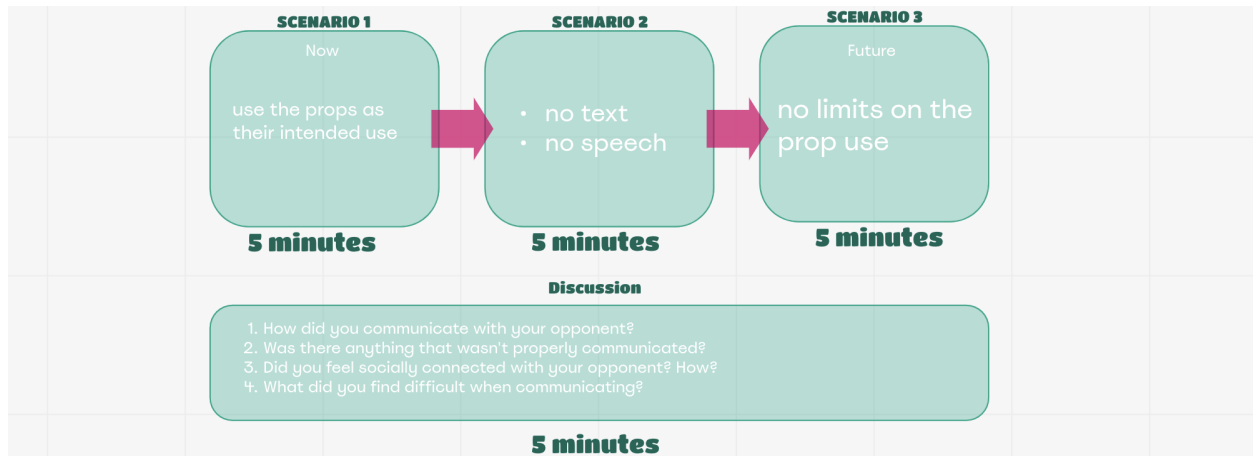


Figure 6: Visual representation showing the structure of the bodystorming session.

We believed we had acquired a number of new and unexpected innovation options after our bodystorming session. It was now time to bring these viewpoints together through simple reasoning to identify which responses were shared by most participants and where they perceived our project's strengths [6].

Brainstorming

We plan to use brainstorming throughout the project's duration. We aim to approach our difficulties with an open mind when brainstorming, avoiding passing judgment on other group members. To help us keep on track with this strategy, we should strive to clarify our difficulties or queries. Sketching or diagramming can improve our brainstorming by allowing us to open up and see things clearly, allowing us to build on the ideas of others. Finally, it will be critical to be respectful and stick to one topic at a time, which will make reaching definite conclusions much easier [4].

4.4 Prototyping Methods

Prototype materials and programming

For prototyping the products we aim to use are Arduino [38] and TinkerKit [39] sensors to enable programmable features that enhance the embodied experience for the user. Further explanation of Arduino and TinkerKit and how they will be used can be seen in *section 5.2 2nd Iteration*. Other materials, such as styrofoam, cardboard and wooden sticks will be used to create low-fi prototypes. The prototyping and testing will be executed in iterations to enable us as designers to implement new functions and features to the product easily.

Sketching

We will produce ideas and visually communicate them to both internal and external stakeholders via sketching. Because it will be done in low fidelity, sketching will also give fresh information

to us in a fast phase. Finally, visualizing user flows is a key component of sketching and important during all future implementations [4].

Wizard of Oz Testing

Due to the scope of this project and technical limitations, there are times when prototypes cannot be made fully functional for user testing. In such cases, a Wizard of Oz approach is usually taken. In this approach a simple prototype is tested and certain parts of the prototype are simulated by a human operator who is behind the scene and performs the task that was intended [14]. We notified our users about this approach prior to user testing. We may test functionality without fully committing to the time and resources required for full constructing or programming by using Wizard of Oz. As a result, we can make modifications and enhancements considerably more quickly [25].

5. Overview of design iterations

5.1 1st Design Iteration

Data analysis - categories and themes

After gathering all data from the observations and bodystorming session, we transcribed the recordings and discussed our notes. Furthermore, we conducted an analysis to identify common themes and patterns in the data (see *Figure 7*). We mostly focused on highlighting information that was related to social connectedness in regards to the reflection after a round ends. This information was then used to discuss commonalities that could be incorporated into a design.

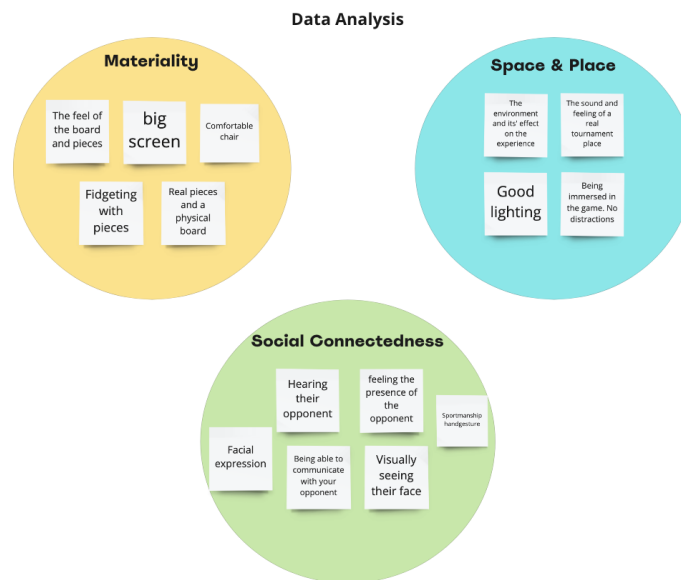


Figure 7: Prototype 1 - Categories emerged from the analysis

5.1.1 Prototypes

The prototypes are created for the post-round reflection, which currently isn't happening often in a hybrid chess environment, compared to in an offline environment. These prototypes are designed to create more social connectedness between the players and enhance the experience.

Prototype 1

How does it work?

The setup of this prototype includes a physical chessboard, a screen, and a webcam. The screen is the part of this prototype that includes most aspects of social interaction. What the user can see on the screen is their opponent's upper-body and their chessboard, where the round is played. The camera is wide-angled, so it has the ability to capture the player and their board. On top of that, the user will have the agency to choose the additional information on the screen, which could for instance be the round protocol or a digital chessboard, visualizing the board state. As shown in *Figure 8*, prototypes concerning this design were carried out using physical materials, such as cardboard and styrofoam, as well as using images to put together the design idea on Miro.

What is it based on?

This prototype is based on the social aspect of being able to see your opponent and also having an simplistic setup. From observations and interviews, we have found that seeing and hearing your opponent potentially increases social connectedness [22], therefore including that visual aspect in a hybrid setting would be advantageous. From the bodystorming session the participants mentioned that if they are able to see their opponent they are more likely to analyze the game afterwards compared to if they can only see their opponent's name on the screen. In this prototype, we also chose to include a physical chessboard and not replacing it with an online board, since previous research on materiality in relation to playing online or hybrid, talks about the importance of playing with real pieces [4].

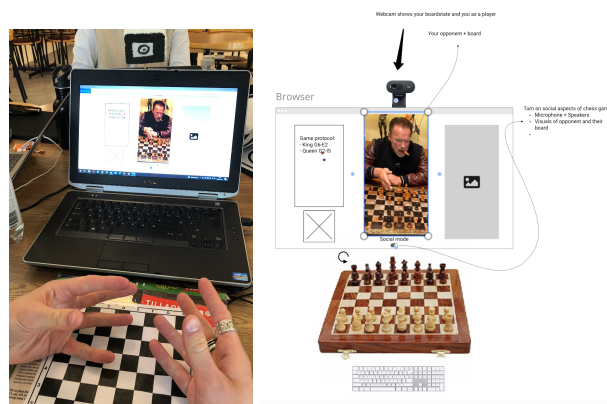


Figure 8: Prototype 1 - in physical prototyping materials and screen-based representation.

Prototype 2

How does it work?

This prototype functions as a specific space where the user can feel immersed in an environment that feels similar to playing chess with a person in real life. The prototype includes a large screen that is used to show the opponent's face and body, making it feel like the players are sitting across from each other. Speakers are included to mimic the sound of a chess tournament where there is some ambient sound. The user will have the agency to select which type of sound they wish to hear, including the volume on ambient sound as well as on the opposing player. The chessboard that is included in this prototype is an automated chessboard. When a player moves their pieces on their board, the same pieces on the opponent's board move correspondingly. For this prototype, both players need to have the same setup, or at least they both need the same board. This automatic chessboard was inspired by the project Square-off [40].

What is it based on?

From research carried out by observations and interviews, specific aspects that were brought up by participants have been implemented into this prototype. These aspects are how sound is an important part of chess, visually seeing your opponent increases social connectedness [22] and creating a designated space for chess could be beneficial to the overall experience [18]. The aspect of space was taken into consideration here, the aim with this prototype was to create the same feeling as the players would get from entering a space like a "real" place [9,12]. Here we also took into account the materiality aspects of having a real board and real pieces, also the feeling of playing against a real opponent that moves their own pieces and for the players to get a similar feeling in a hybrid practice as they would in an offline setting.

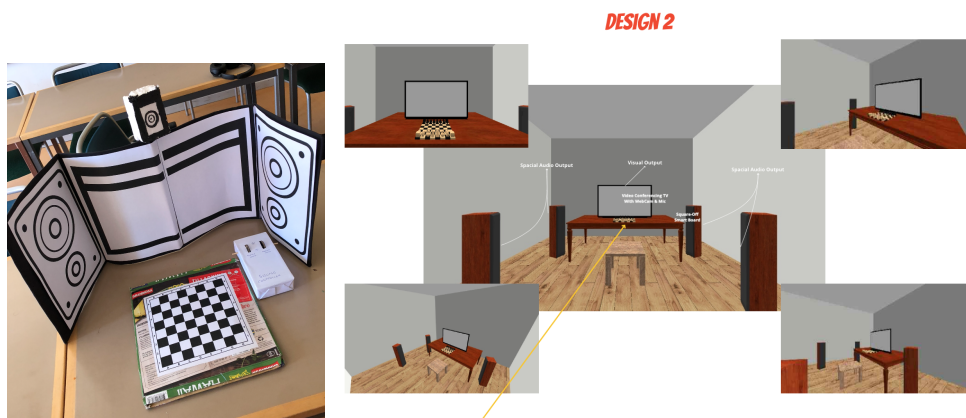


Figure 9: Prototype 2 - Shown in physical prototyping materials and screen based representation.

Prototype 3

How does it work?

This design is based on using virtual reality (VR) goggles to simulate playing chess in the physical world. As can be seen in *Figure 10*, the players can be located in different locations and use the VR goggles and haptic feedback gloves to simulate a chess round. Where the whole experience is taking place in the virtual world. The players would have the opportunity to create their own avatars to simulate them while playing.

What is it based on?

From our bodystorming session, it was found that vision, hearing and sense of touch were important to the overall experience of the chess round. This is based on an already existing solution for VR chess [41]. A virtual setting was found to be lacking the emotional warmth and the presence of another person [3], which was one of the aspects that we found when conducting interviews during our epoché observations in *section 2.2*.

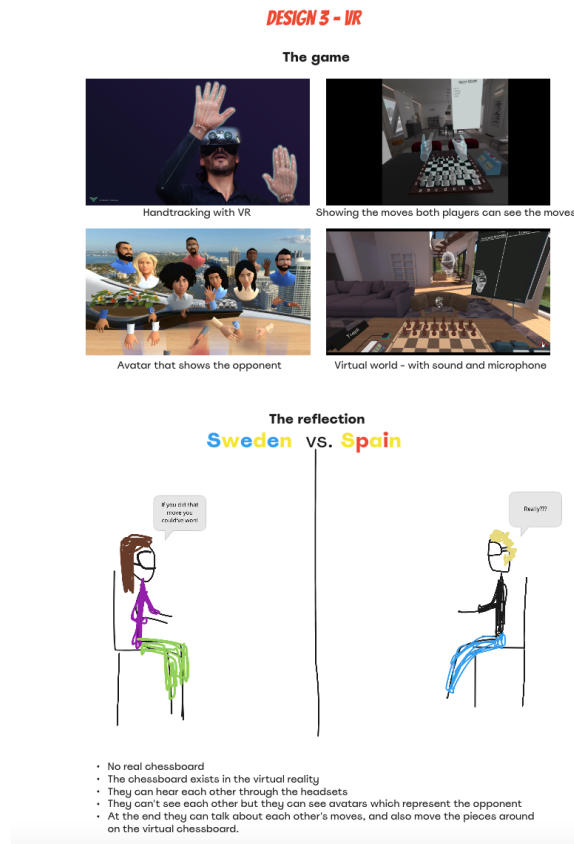


Figure 10: Prototype 3 - Screen-based representation

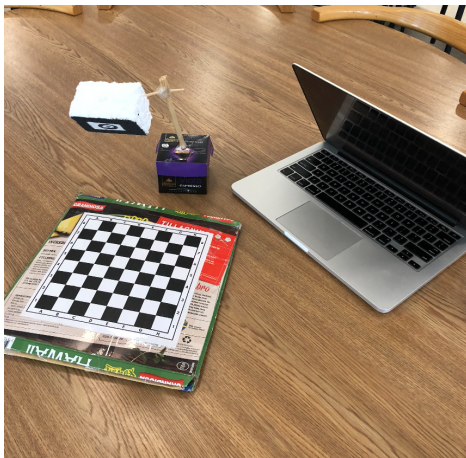
Prototype 4

How does it work?

This prototype includes a set-up of a laptop, a webcam and a physical chessboard. The laptop is used to play the chess round on and the webcam is used to visually portray the player and their physical chessboard. The chessboard will function as an aid for the reflective discussion at the end of the round. The chessboard has the ability to light up specific squares by tapping on that square, and when a player has tapped a square, the same square on the opponent's board will also light up. This simulates the in which players point to specific squares during the after-round discussion.

What is it based on?

This prototype is based on visually seeing and hearing your opponent which increases social connectedness [18]. On top of that, the chessboard aids the players with communicating specific moves on the board, which overall benefits to the social connectedness between players. This prototype builds on the aspects of materiality, the physical aspect of having a real board and pieces [22]. In addition to social connectedness, lights has been shown to increase the feeling of presence between people [21,23].



DESIGN 4

This design is based on the square off automated chess board

- A laptop on the side is where the chess game is actually happening
- The squares on the chess board will light up where ever the pieces move, letting the opponent where to place the opponents pieces.
- There is a camera and microphone that is built into the board.
- The social aspect of the analysis/reflection at the end of the is enabled through the players seeing each other.
 - In this scenario it might be difficult to understand which square a player is referring to. However, lighting up specific squares makes it easier for the player to understand

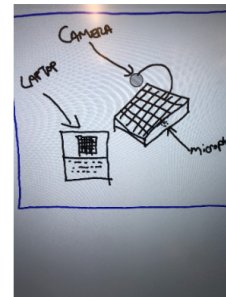


Figure 11: Prototype 4 - Shown in physical prototyping materials and screen-based representation.

5.1.2 Testing & Design Critique

The first testing was completed with two target users, where we presented and/or tested the three designs.

Test 1

The first testing was done with user 1 where the player was going to test one low fidelity prototype at a time and then participated in a semi-structured interview, regarding the designs and their experience (see *Appendix 4*). The first method was chosen because the player was able

to attend physically. We wanted to enable as much interaction as possible with the prototypes made out of cardboard and styrofoam, which resulted in player 1 sitting in front of each of the three prototypes and getting a description of their functionalities and the different features. We decided against using the Wizard of Oz method in this first round of testing since we wanted to get a feel for our ideas and how we wanted the various solutions to work. We thought that this would let the player be more free and open to share ideas on how to improve the existing features when asked questions. With this method we got new input from the tester as well as a comparison of the three. All prototypes had features that we wanted to combine into two prototypes.



Figure 12: Testing 2 - Physical and in-person testing of prototypes

Test 2

The second testing with user 2 was done remotely via Microsoft Teams, which limited the interaction with the prototypes and may have narrowed player 2's understanding of the prototypes. It was done remotely since player 2 was not able to attend on-site, therefore we had to adjust parts of the test. This testing was conducted as a presentation of the ideas, similar to what was done in test 1 without getting the "real" feeling of an experience. The same questions were asked as in test 1 (see *Appendix 2*). We noticed that it was difficult to describe the prototypes correctly, and small features were forgotten or not discussed properly. We mostly got overall feedback on the entire solution, rather than focusing on what features enable social connectedness and enhanced the experience.

Feedback for prototype 1

The feedback we got for prototype 1, from chess user 1 was that it was accessible, that it didn't require a lot of setting up, and that it would be easy to use. The negative aspects of this prototype were that the player would see their opponent's board mirrored, which would make the analysis more difficult, and they would have to rely on speaking about the boards corresponding numbers and letters. User 1 also added that the chess player should be given more agency on what elements the interface should include. User 2 (the remote testing), was enthusiastic that you would be able to both see the person that you played against as well as the board simultaneously. User 2 mentioned that this would be a great addition to the analysis of hybrid chess. The thing that user 2 believed was missing in this prototype was the handshake at the end of a game, which is an important aspect when playing chess. Another suggestion to the prototype was to give the players agency to choose their own look of the board and pieces, the player said that not incorporating this would be a loss.

Feedback for prototype 2

In prototype 2, user 1 liked seeing their opponent and being able to see their facial expression and the player added that when seeing your opponent would more likely lead to interaction and analysis together afterward. User 1 said "...like in zoom when you see a person and no one says anything, you feel like you need to say something because of the awkwardness.", upon seeing your opponent you would get a better connection than if you hadn't. The experience with prototype 2 was more of an immersed feeling (than prototypes 1 and 4) and one that user 1 wanted to explore further, and also that this experience was similar to what an offline round would look and feel like. This prototype would also benefit from a handshake, with some sort of reaction and also generate a good feeling afterward. User 1 mentioned that you get more involved when playing offline, and this prototype could recreate that. User 2 also mentioned that this prototype would enable viewing your opponent on a new level and that this also looks appealing. This prototype would remove a lot of distractions and let the player focus on their round, and it also encourages to have that social aspect of chess that is lost when playing online.

Feedback for prototype 3

From our testing we realized that our users talked about the importance of having a real chess board and the pieces for the play. They were not so excited about having a virtual-reality based solution hence we decided to drop this idea in the upcoming design iterations.

Feedback for prototype 4

Here, user 1 said that being able to see the opponent tapping their board with lights would enhance the social connectedness and interaction with the other player. Additionally, the player mentioned that this design would make it feel more like playing against a real human. Incorporating a camera in the design was found to be a necessary aspect as according to user 1 it

helps in encouraging the talk after the round ends. User 2 also mentioned the fact that being able to experience the feeling of being in the same room is “very interesting” and also adds to the aspect of social connectedness. In addition, user 2 emphasized the importance of the environment in relation to the experience when playing chess. If the player has the option to change and/or choose the physical environment it could lead to a more positive experience of chess. On the contrary, user 1 also mentioned a negative aspect of the design that could be improved. One weakness was that the design has two components, which according to user 1 would require a shift in focus to be able to socialize with the opponent. This was compared to design 2 where all the information needed is in the same field of view.

Feedback from Design critique 1

After testing the prototypes with participants, the group presented all designs and testing results in a seminar to gain a new perspective with the help of our classmates. This design critique session led us to think more about the level of embodiment for prototype 2. Since we have received positive feedback on certain features of prototype 2 from user testing, we aim to keep those features and implement those in future prototypes. From our testing and the design critique session, we will evaluate which features and functions of all designs are the most appreciated and continue to design additional prototype(s) with those features and functions.

5.2 2nd Iteration

MoSCoW prioritization

In order to structure the feedback we got from the testing in the first iteration, we created a MoSCoW matrix (see *Figure 13*). The focus here was to include feedback that was related to different features, as we wanted to use this information to improve the current prototypes. By prioritizing specific features through discussion the team can more efficiently move forward with future prototype ideas.

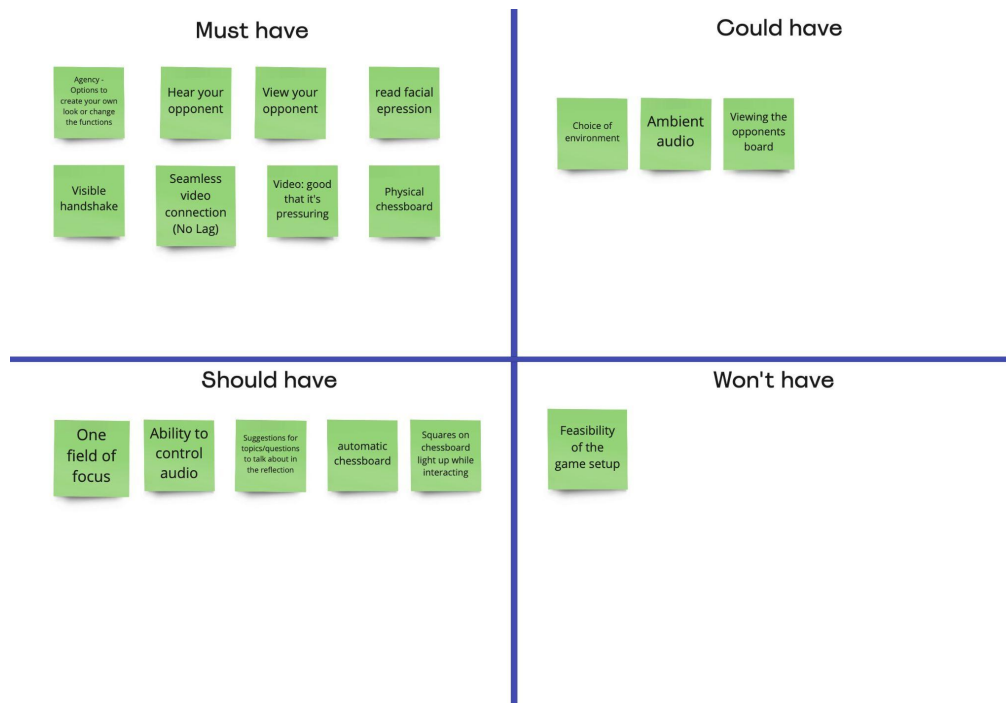


Figure 13: MoSCoW matrix

When organizing the different feedback points into the right categories we mostly based the decision on how that feature could contribute to enhancing social connectedness between the players.

Must have

The feedback points that we believe have the highest priority are features such as being able to view and hear your opponent, being able to read facial expressions, having a physical chessboard, and a visible handshake. Additionally, we noted that the testers mentioned that they want to have more options to customize different functions which is also another aspect that could enhance their social experience. All of these points were mentioned several times by different testers as well as the bodystorming session. Therefore, we believe that these are vital features to include in order to enhance the social connectedness in the reflection after a round of chess.

Should have

The points that we included in the should-have section are features we believed were relevant for enhancing the social experience but possibly not essential. For the first two points, one field of focus and the ability to control audio, we did not have enough feedback to determine if it was a vital feature or not. As for the third point - suggestions for topics/questions to talk about in the reflection - it was mentioned by a tester and we wanted to explore it further as we thought that it could add to enhance social connectedness. Additionally, we included the idea of having an automatic chessboard where the pieces would move automatically on the other person's board

when one person is moving on theirs'. We found this from an existing solution of hybrid chess and thought that this feature would help users communicate more easily with each other without the hassle of having to move the opponent's pieces, as well as their own. An additional idea that we added here was to have the squares on the chessboard that light up while interacting, meaning that they would be able to see each other's moves. This was a feature we had included in our previous prototype that received positive feedback in regards to making the user want to interact more than simply playing digitally on a screen.

Could have

For this section, we added features that we believed would be pleasant for the user, but might not enhance the social experience. These features were: being able to choose the environment, having ambient audio and viewing the opponent's board. Based on the previous feedback from our testers, we found that having the ability to choose the environment and having ambient sound were aspects that would enhance the experience. However, we believed that these features would be more connected to the overall experience and not specifically enhance the social experience. In addition, testers mentioned being able to view the opponent's board when reflecting after a round. This is something we decided to not highly prioritize as hybrid is defined as using a physical board and therefore a digital chessboard would be redundant.

Won't have

The only point we decided to exclude was the feasibility of the game setup. This was a point of discussion in our previous design critique session, where we reached the conclusion that we're not going to consider the accessibility aspect of the setup.

5.2.1 Prototypes

After creating a priority list of the features and functions that we wanted to include in the prototypes, we participated in a hackathon session where we were able to ask questions regarding the practicalities of building our prototypes.

Prototype 5

How does it work?

This prototype is composed of a large screen, a chessboard where the squares have the ability to light up and in a way for the users to hear each other. The large screen is there for the users to be able to see their whole opponent. The screen also allows players to interact with each other and after the chess round has been played and before the reflective analysis, they will have the chance to give each other a high-five which can be seen in *Figure 14C*. The chessboard, as can be seen in *Figure 14B*, is one that is made out of cardboard and on it are buttons and LED lights. By using an Arduino and TinkerKit we were able to program the buttons to turn on the light on the opponent's board on the corresponding square. *Figure 14A* above shows a simplification of

the prototype in a sketch, and here the user is wearing headphones to be able to hear their opponent.

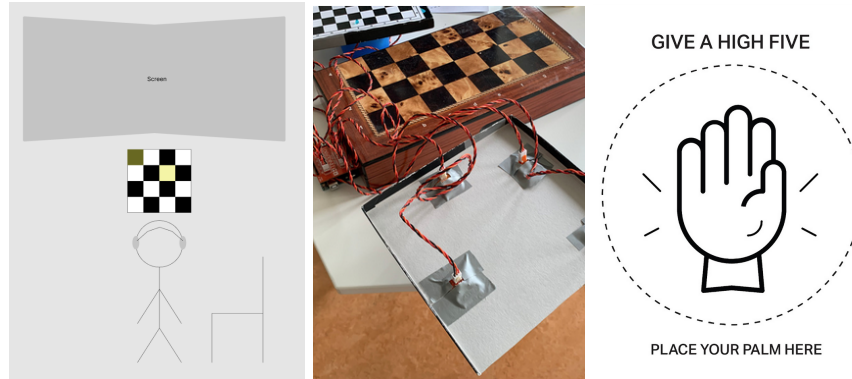


Figure 14: Left-hand side image: 14A Prototype 5 - Shown in screen-based representation
Middle image: 14B Prototype 5 - Shown in physical prototyping materials.
Right-hand side image: 14C High-five feature on screen

What is it based on?

Based on testing with users in previous iterations, we were able to come up with this prototype. It includes features and functions that have been taken from multiple prototypes from the previous iteration, that the participants felt were the most important. The ability to see and hear your opponent during the reflective analysis was an important aspect of the previous user testing as well as previous research [18]. In this iteration, the feature of the handshake after the chess round is something that we tested for the first time after having heard it from participants from testing 2 in *iteration 1*. After a chess round has been played the participants usually shake hands or have some form of physical interaction, as talked about in *Section 2.2*. To mimic this physical interaction between two players we brought forward an augmented feature on the screen where the players place their hands on the same part of the screen at the same time [2]. From the previous user testing, the lights on the chessboard received positive feedback and we decided to implement that feature again in a prototype that is more interactive compared to the previous iteration.

Prototype 6

How does it work?

Prototype 6 is similar to prototype 2 in that it includes almost all the same features and functions. This prototype is composed of a large screen, a chessboard, and the function that users will be able to hear each other. The screen and the auditory feedback that the users receive will be the same as in prototype 2. The difference for this prototype lies in the chessboard. This chessboard is an automated one, meaning that when a player moves their pieces on their board, the board will automatically move the same pieces on the opponent's board in a corresponding manner.



Figure 15: Prototype 6 - "Wizard of Oz" approach to mimic automated chess board

What is it based on?

The automated chessboard is a feature that has been discussed in previous user testings and has received positive feedback. The idea behind it is that it should mimic the way in which players communicate about specific moves without having to be in the same location and using a computer. Using a physical board is a criterion that cannot be dismissed because of the definition of the hybrid environment of chess in addition to comments made in previous user testings, as seen in *section 2.2* as well as from research that presents the importance of the physical board [18].

5.2.2 Testing & Design Critique

We invited two participants to play against each other in our second round of prototype testing. The two players sat on opposite sides of a wooden "screen", allowing them to see each other but not the other's board. They were now able to hear and see each other's faces, simulating the use of a webcam (angled on the face) and microphone with the addition of sound speakers. The wooden screen, like a regular computer screen, has the ability to display many types of information (see *Figure 16*). As such, the participants were greeted with paper banners indicating which city they represented in this chess game, depending on which side they sat down on. Both participants also received a cardboard chessboard that already had some chess pieces on it. The wooden panel displayed a cue to both participants before the game began, asking them to replicate a physical high-five in front of the screen (see *Figure 16*). This gesture mimics the sportsmanship handshake that is offered in a genuine chess-playing context, after a round of chess is played. Following a cooperative completion of this task, post-game reflection can begin, with both players viewing suggested discussion topics on the screen.



Figure 16: Testing. Players doing sportsmanship hand-gesture

Prototype 5

The players are requested to explain and debate subjects such as "what went wrong/right in this game" in the initial prototype, while relaying this information to their opponent. Our illuminated chessboard (see *section 5.2.1 Prototypes*) assisted them in performing this task, and the two participants moved pieces about on this board to depict different board conditions. The two participants were urged to communicate with one another and to use the various tools.

Prototype 6

The participants got to play on an automated chessboard in the second prototype. This outcome was achieved by one of the test leaders swapping the board-states on the opponent side of both chessboards using the Wizard of Oz method. They were given the same task as in the previous prototype, which was to discuss various parts of their chess game while engaging as much as possible.



Figure 17: Testing of prototype 5 & 6.

Feedback comparing prototypes 5 and 6

After the testers had reflected on the game, we asked them several questions regarding the prototypes. In contrast to previous testing sessions we wanted to let the participants compare the two prototypes. The questions that we asked can be found in *Appendix 4*.

What we found from this interview with both participants was that the lights and the buttons in prototype 5 were difficult to use, since they were placed on only a few squares on the chessboard. Additionally, the participants believed that it was easier to communicate in prototype 6, as they didn't have to move their pieces, however, this also meant that there was less interaction with the opponent. One major problem that both participants experienced with prototype 5 was that it was difficult to show and explain a sequence of moves, which they believed was solved in prototype 6. Another weakness that one participant mentioned with prototype 6 was that there was no way to let the opponent know when you're talking about a piece, without moving it to another square on the board. In regards to the high five after ending a game, the participants thought the action felt awkward but liked the idea of having an end-gesture before the reflection. One participant said it could be enough to create emoticons that the players could press on the screen. A final feedback point that we will consider in our future testing session, was that the testers should play a real game before starting the reflection as it would help in making the conversation and the feedback more authentic.

Feedback from Design critique 2

The group presented all designs and testing findings at a seminar, after the second testing of our two new prototypes with participants, to acquire a new viewpoint from other students. This

design criticism session got us thinking about materials and how we might test which one was the best. We also need to consider how to envision a chess piece being raised or handled, for which we mentioned sound and lights. Finally, the students addressed several digital features that would be interesting, such as the ability to draw arrows on the board in some way. Overall, we received useful comments and felt that we had a line of reasoning to continue upon in our following prototypes.

5.3 3rd Iteration

Data analysis prioritization

After the third week's testing with participants, we gained further information on how we can improve our designs. The group analyzed the data from the testing by discussing the most important aspects that were brought up by the participants during the testing. These aspects were presented in a visual representation that can be seen in *Figure 18*. From this analysis we were able to prioritize which aspects of the prototypes that were the most important and should be kept for the 3rd iteration. The circle on the right side represents the main features that the final prototype will have. In each of these parts (pieces, environment, handshake and board), there are sticky notes stating the specifications of the parts.

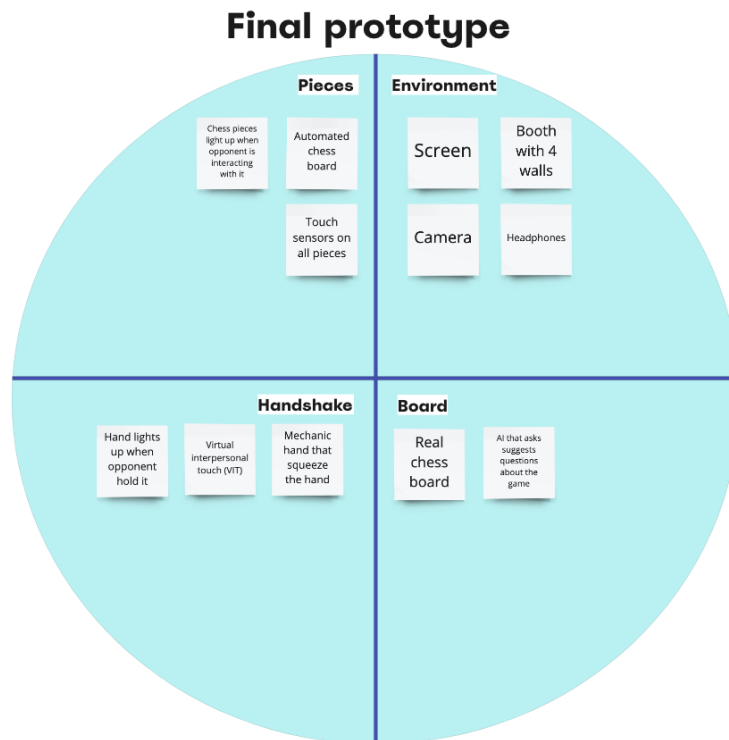
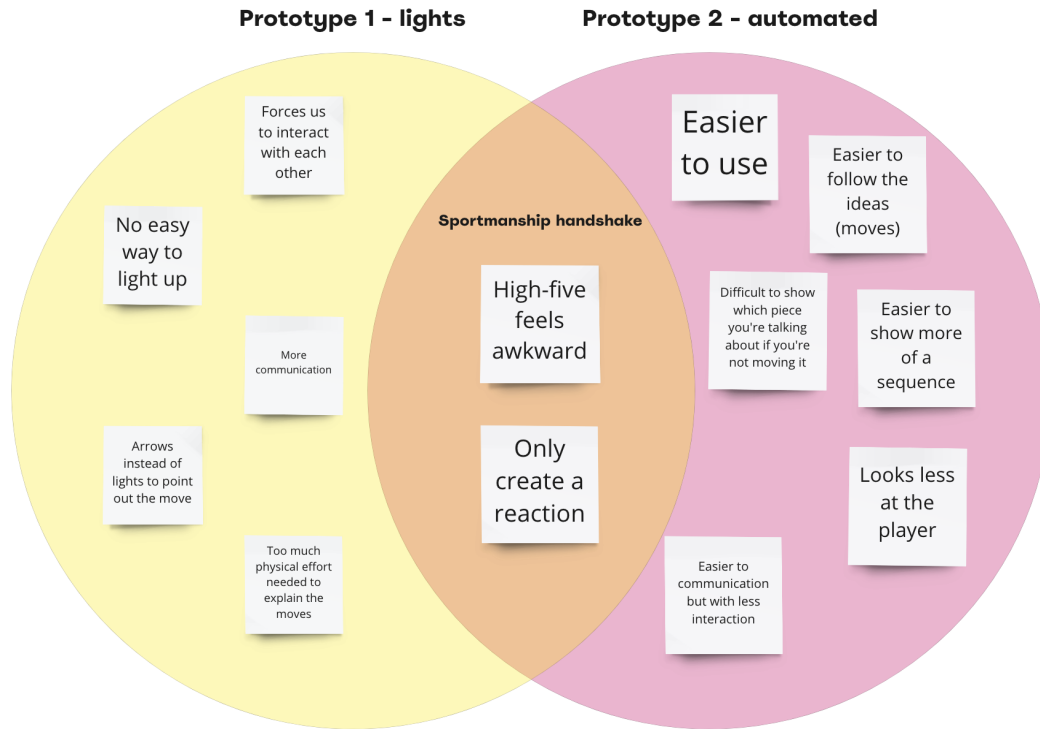


Figure 18: Result of data analysis of testing

5.3.1 Prototypes

Prototype 7

How does it work?

This prototype includes features that were included in the previous prototypes such as the automated chessboard and using lights to interact with the opponent. The automated chessboard feature is the same as in the previous prototype, which means that when a player moves a piece on their board, it will automatically move on the opponent's board. The first feature that we decided to change was the sportsmanship gesture after the game ends. We wanted to replicate the handshake that we had observed in the chess tournament, in order to create a way of engaging “physically” with the opponent. This was done by creating a robotic hand that both players can hold. When one player is holding the hand the opponent will get notified through a light in their robotic hand that signals that the other player is ready to “shake hands”. When both players have placed their hands in the robotic hand, it will squeeze the hand to indicate a physical handshake. After the handshake, the players are presented with suggestions for questions and discussion points on their screen. These suggestions are generated by an AI and are based on the moves that have been made by both players in the game. The purpose for these suggestions is to help the players start a reflection session after the game, where they can replay and analyze their own and the opponents' moves.

What is it based on?

The haptic feedback feature with the hand gesture was added as previous research by Reed et al. [2011] has shown that the use of haptic technology can aid in transferring emotions, which is what we want to achieve with the handshake gesture as it shows good sportsmanship and respect [15]. The use of lights to enhance social connectedness is also supported by previous research from Visser et al. [2011] and Tollmar & Persson [2002] who both demonstrated how light can be used to show remote social presence. The use of lights in the pieces are used with the purpose to help users communicate remotely as well as providing the feeling of playing against a real human and not a computer.

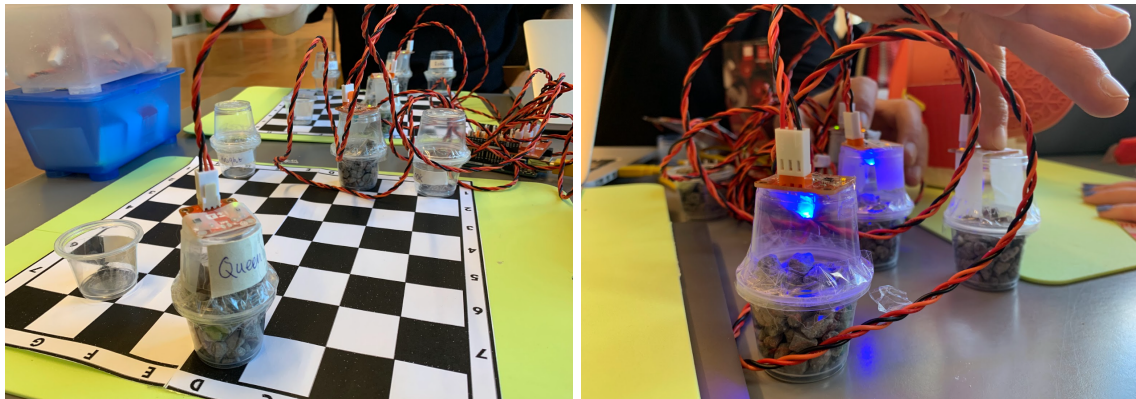


Figure 19: Prototype 7 - the illuminated pieces function

5.3.2 Testing & Design Critique

Since we received feedback on some of the features from the previous testing, we decided to focus on the new features. The new features were the lit-up chess pieces and the handshake. We invited two participants to test and evaluate our prototype for this iteration. Before the testing, we asked the participants to play a short game of 2 minutes to become familiar with the prototype and to have moves to discuss during the reflective talk after the round. In order to mimic the automated chessboard, we as moderators manually moved the chess pieces to the corresponding square on the opposite board using the Wizard of Oz approach. During the player's discussion, we provided questions about their round to enhance engagement which was seen in previous testings. In this testing, the participants also evaluated the new handshake feature which can be seen in *Figure 20*. After the participants felt finished with their discussion we conducted a semi-structured interview with the participants.



Figure 20: Testing of prototype 7

Feedback from testing

Questions that were asked in the testing can be found in Appendix 5.

Overall, both participants felt like this prototype changed their experience of chess for the better and it got them talking to their opponent. They also like the part that the setup is the same as regular chess and its simplicity.

Communication and Social Interaction

The participants felt like it was easy to communicate which chess piece they were moving because of the lights. One of the participants mentioned that this version is more socially interactive than the games they have played online during Covid-19. However, there was not much eye contact since the light took their attention.

Discussion Questions

The questions that the participants were given were in the design idea generated by AI but in this case written by one of the facilitators. The participants mentioned that this aspect was good because they would not have thought about those questions themselves, if it was appropriate questions.

Improvement Suggestions

They also mentioned that using voice recognition to move the pieces could be interesting. It would be nice to have a digital board on the screen while having the discussion however it is not necessary during the game. The participants felt like the prototype would be better if the pieces were real. The handshake was at first a bit confusing to the participants and they felt like they would need some instructions on the screen that explains how to use it.

Interview

An interview with a participant that has been involved in our project since the beginning took place where we first explained the current prototype's features and functions. Next, we asked questions that can be found in *Appendix 6*. The participants initial interaction with the prototype was that the robotic hand didn't feel natural, since it was visualized as a glove in the prototype. The interviewee mentioned that a way to improve could be to make it less startling, meaning to make it more discrete. We brought up earlier functions in previous prototypes about this physical interaction and the participant supported the high-five interaction much more than the robotic hand. The participant believed that this prototype enabled social interaction between the players and they compared it to their most used online chess website, Lichess [42], where the only social interaction is via a chat. We decided to ask this participant what their thoughts on the material of the board were because it was not brought up in previous testings. The participant spoke from experience and said that they want the setup to be as close to normal as possible, meaning the classic chessboard look and that the materiality itself is not an essential factor.

Feedback from Design Critique 3

In the final design critique session, we presented the physical prototype and demonstrated its different functions. The overall feedback we received was positive and they communicated how they liked both the use of lights on the pieces and the automated function. Additionally, they addressed two major concerns and questions that we discussed during the session. The first was regarding the automated function and how it would look like when a player wants to show that a piece captures the opponent's piece. Here, we discussed two possible solutions: 1. The captured piece would automatically move outside the board or 2. The captured piece would light up in a red color that indicates to the player that they should remove that piece. The second point of discussion that was brought up by the students and teacher was regarding the "robotic hand". They had a shared opinion that if the hand is designed to look realistic then it could be quite

disturbing for the player. Therefore, we discussed how we could design an artifact differently but still incorporate the same haptic feedback.

6. Final Solution & Final Evaluation

After three iterations of prototyping, user testing and design critiques, we have carefully analyzed the feedback we have received and designed our final solution. To enhance the social connectedness in hybrid play we propose a setup with various elements that will engage players and provide an immersive post-round conversation as close to a normal co-located experience.

How does it work?

This final prototype includes the following elements:

1. **Smart Chessboard** - An automated chessboard like Square-off [40] will be used as it reflects a remotely located opponent's move automatically, thus reducing the physical effort in moving the pieces.
2. **Illuminated Chess Pieces** - Pieces on both chessboards illuminate when a player interacts with them by touching or holding them. This visual feedback is essential to create a sense of “presence” for the opponent, who will know that the pieces are interacted with, by the other player [24].
3. **Screen** - A large screen will be used to display the video feed of the opponent. The screen enables a player to view the facial expressions and body language of their opponent.
4. **Web camera** - A web camera is used to capture and stream the visual feed to the players on the screen.
5. **Microphone** - A microphone (built-in or external) is used to capture and stream the audio feed to the players.
6. **Speakers or Headphones** - Speakers or headphones are used as the output for the audio feed.
7. **Walls** - Walls will help in reducing the distraction and bring in a sense of focus when players are playing with the setup. This will also be helpful when multiple similar setups are put up in the same place.
8. **Handshake** - In order to mimic the sportsmanship handshake after the chess round is finished, this prototype includes a mechanical hand that appears when a player reaches out their hand for a handshake. This mechanical hand will give the user haptic feedback mimicking the handshake of their opponent.
9. **Discussion Questions** - After the round is finished, the users will be given suggested discussion questions to talk about that reflects the round the players had just played.

To use this design, the user will sit down in what could be described as a booth with dark walls surrounding them to not distract them from outside stimuli. The user will be connected to another

player who wishes to play the same social round of chess via video call on a large screen as can be seen in *Figure 21*. By wearing noise-canceling headphones outside noise will not distract the user during the round of chess. During the round, the pieces will automatically move based on the opponent's choice of move on their chessboard. In addition to the automated board, the pieces will also light up when a user is interacting with it, meaning touching or moving it. The piece will both illuminate on their own board as well as their opponent's board. After the round is finished, when a user reaches out their hand to give a handshake to their opponent, a mechanical hand will appear on the user's right-hand side for them to give a handshake to as can be seen in *Figure 21B*. The mechanical hand will squeeze the user's hand to mimic the presence of their opponent. Finally, this prototype includes suggested discussion questions about the round of chess that the players had just played. To see the final video presentation click on this [link](#).



Figure 21 - 21A: Setup of final prototype, 21B: Mechanical handshake

What is it based on?

From previous observations and interviews we have found that the environment is a very important part of the chess experience. Our setup will be designed in the form of a booth surrounded by blinds. These booths can be set up in chess clubs, federation headquarters, hotels or any other public places as accepted by the hybrid chess standards of FIDE [13]. The ability to see and hear your opponent is a social aspect that is based on the observations and interviews with participants where have stated that seeing and hearing the opponent increases social connectedness. Tyrer [2021] also supports this claim, where it was suggested that seeing and hearing your opponent potentially increases social connectedness [22]. Based on previous observations and interviews, the feature of the automated chessboard will also be included in the final prototype since participants have supported the element. Participants have mentioned that when the pieces move automatically it mimics the experience as if the opponent was in front of them. The feature of the illuminated chess pieces was also supported by both observations and interviews and as well previous research such as Visser et al. [2011] and Tollmar & Persson

[2002]. These authors demonstrate how light can be used in remote environments to invoke the feeling of presence of the other person [20, 23]. The handshake feature is based on research carried out by Reed et al. [2011] which shows that using haptic technology can help with transferring emotions. Because the handshake is a way to show good sportsmanship and respect [15], we want to in some way transfer these elements to the other player and the haptic handshake allows for that.

Based on previous user testings the feature of having suggested discussion questions about the chess round during the reflective analysis will be included as an option for the user. To support our own findings, research has shown, according to Adamson et al. [2013] and Kuthy et al. [2020] AI-generated questions can aid discussions and social conversations. Some participants mentioned that this feature is something that might be useful if the topics of discussion are relevant. Other participants mentioned that they would most likely not use the questions since they would be so immersed in the game and know what to talk about when it comes to the reflective analysis after the round. Therefore, including the feature as an option for the user will increase satisfaction.

6.2 Final evaluation/testing

The final evaluation was set up in a hybrid setting where the opponents could only see each other through the screen and hear each other through their noise-canceling headphones. The final evaluation was done with two participants that got to experience the prototype in its final state. First the participants played a quick game online together for two minutes each while sitting behind dividers, then they set the board in a chess formation from the round they just played. For this test we started a Zoom call in order for the opponents to see each other, they each used one real chessboard each with both white and black pieces. In order to simulate the automated board we had to Wizard of Oz the chess pieces automatically move and light up. Therefore two of us in the design team stood beside one tester each, as seen in *Figure 22*, where they moved the chess pieces and lit them up, with the use of small white bike lights, at the same time, to show how the opponent moved the pieces on their own board. The two members from the design team were in a video call with each other in order for them to know how the other tester moved their pieces and recreating that exact move at the same time on the opponent's board. They analyzed the round for about 15 minutes. One of the testers also had the automated questions beside their view of their opponent, as seen in *Figure 22* on the left tester.



Figure 22 - Final evaluation

One member of the design team also initiated a sportsmanship handshake, since the handshake wasn't shown in the setup. The mechanical hand was raised when one opponent initiated the handshake by pressing an imaginative button.

Feedback from evaluation

The questions that were asked in the final evaluation can be found in Appendix 7.

The final evaluation was more focused on how the prototype/solution enhances the social connectedness in hybrid chess, and the questions were regarding what and how it enhances social connectedness in hybrid chess. The initial thought from both participants was that it was a fun interaction and experience.

First tester

The first tester mentioned that it would be a fun experience with someone your own age and that spoke English, made you feel more connected and also stated that the likelihood of doing this with a stranger was slim. Although the tester also stated that having an analysis with your opponent like this was enhancing the feeling of social connectedness to your opponent. The tester continued by saying that this was much more social than when your opponent is called anonymous. The board was good and helpful when conducting the analysis and it made it more fluent. The discussion topics weren't used, the tester said that if you didn't have any of your own questions they wouldn't start an analysis at all. The lights didn't help that much either since my opponent mostly listened and watched what I did. The handshake felt strange according to this participant, and they wouldn't use it.

Second tester

The second tester said that this was a very cool experience that enhanced the social connectedness, and that this setup was more about giving ideas to each other which was pleasing for this tester. The lights stood out for this tester and helped in focusing on what the opponent said rather than trying to figure out what pieces were discussed. This setup had extra add-ons compared to a physical setting, which made the playing much more social compared to playing online/hybrid according to the second tester. It was also mentioned that it felt much more personal when seeing your opponent and it being a real person, wasn't any barrier between us. This tester also found that the discussion topics were unhelpful, since the tester asked his own questions and chose what to reflect on with your opponent. This tester also found the handshake to be weird, but understood the concept of it and what it was trying to mimic which was appreciated.

7. Conclusion

With the growing popularity of chess we wanted to explore how we could enhance the social connectedness of chess in a hybrid setting. Through our design analysis we found that a major aspect of playing chess is how it contributes socially to people's lives. However, our participants believed that the current hybrid and online settings that exist fail to incorporate these social features. Through our observations, interviews, user testings and relevant research articles we concluded that a central point in the social aspects of chess was the reflection and analysis between players after a game ends. Therefore, we decided to investigate how we could recreate the post-game reflection in a hybrid setting.

The solution that we designed focused on enhancing the communication between the players by having a large screen, noise-canceling headphones, and automated boards including pieces with lights. Although the players are not situated in the same location the goal was to make the players feel as if they were closer to each other, hence the implementation of the big screen and the use of noise-canceling headphones. This differs from the current hybrid chess settings, where the players usually can't see their opponent. By incorporating both visual and auditory elements we aim to strengthen the social connection between the two players, and convey the feeling of playing against another human and not a computer. Additionally, we implemented the automated board and pieces with lights to create more effortless communication between the players. This was incorporated since the participants in our first interviews expressed how during the reflection they discussed their moves by physically moving the pieces on the board, which was found difficult to do on a screen. The automated feature and the lit up pieces enables the player to focus on the verbal communication with their opponent, while still being able to follow their pieces on the board. In addition, we implemented lights inside the pieces as a way to create a stronger awareness of the opponent's presence when interacting with the pieces.

To understand how and which features to implement in our design solution we looked into several theoretical concepts of embodied interaction. Through our observations, interviews and previous research we noted the importance of materiality in chess [18]. How the players feel when playing the game impacts their overall experience. The elements of chess which we noted that contribute to the players' experience are things such as the social factors, lighting, the board and the pieces and sound. Therefore, when designing our solution it was important to not drastically change any of these aspects, and instead focus on enhancing the social experience. As a result, the final solution consisted of an original physical board and pieces with add-on features.

Furthermore, we had to understand the different components of social interaction in chess to be able to design a solution that would enhance the social connectedness between the players. From the gathered research we found that an important factor in social interaction online was being able to see the opponent's body language. This is why we incorporated the screen where the players could visually see each other. However, this proved to not be enough in enhancing the social connectedness between the players which is why we further investigated the use of lights in social interactions. The use of lights has been proven by previous researchers to be a helpful method in showing remote presence [21,24]. Additionally, we used haptic feedback to mimic a sportsmanship gesture and further increase the feeling of presence of the opponent.

Finally, we also considered the concepts of space of place when designing our solution. The environment was an element that our participants mentioned several times. It was important to them and to us to replicate the real chess environment since we did not want to change the game experience, rather enhance it. Therefore, we worked towards a solution that would enable an environment where the players would feel more natural in communicating with their opponent.

7.1 Future iterations

In order to optimize our design even further, we'd like to expand the number of test users, while being more rigorous about the sample. Our tests have revealed that some chess players are unconcerned by social connections, while others are. If we truly want to improve our design, we should do further testing on users who are looking for a social game in the first place, in order to get more relevant data. Furthermore, an increase in the number of user tests would improve the validity of our project. With more participants, we would like to put more effort into creating a higher quality design. The goal would be to create a final prototype that is not relying so heavily on Wizard of Oz techniques.

We would like to see more women's perspectives in our sample, as our testing has only been done on men. Investigating both genders' reactions and interactions helps to promote gender equality in sports while also increasing our chances of collecting useful data.

The response to our prototypes' component of a "sportsmanship gesture" indicates that we will need to think carefully about how to improve upon this aspect in a future iteration. Our participants did not find this interaction natural, which raises the question of whether or not this particular physical interaction can be performed in a hybrid setting at all.

While conducting user testing and using a wizard of oz method to mimic the automated chessboard, there were difficulties in rearranging the pieces to be the same on both testers' chessboards quickly. This reflected as if there were connectivity issues while playing from different locations. Therefore, testing the automated chessboard with minimal delay/lag would be of benefit to the project.

Our participants had differing perspectives on what factors influenced social connectedness. Whereas for some, sound and audio were sufficient, others desired to see, hear, and connect with the other player as much as possible. To accommodate a variety of viewpoints, we should provide test users the opportunity to enhance or limit their social experience. They should be able to choose the design tools they want to utilize which would increase the sense of agency.

Regarding the suggested discussion questions, we weren't able to fully test their effectiveness since the questions did not match the played game. Therefore, we would like to give the players the option to choose whether they want to utilize the discussion questions or not. Their impact has yet to be adequately evaluated. However, we believe that if the suggested questions are relevant for the players, such as crucial game state events that clearly determined who would win, it may aid the players, allowing them to use them for solid debate if they so desire.

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Appendices

Appendix 1: Chess tournament interview Questions

Interview with players

Hej! Vi är ett gäng studenter vid Uppsala Universitet. Vi forskar i nuläget på social aspekter i hybrida (offline vs. online) miljöer. Vi har valt att fokusera vårt projekt på schack då det har visats sig vara ett stort uppsving av det under pandemin. Vi är intresserade av hur de sociala aspekterna i schack ändras när det spelas på ett hybrid sätt. Vi uppskattar att intervjun kommer ta ca. 15min. Efter denna intervju kommer vi att sammanställa all data vi har fått och utveckla en prototyp, skulle du vara villig att testa samt utvärdera denna prototyp vid ett senare tillfälle?

Är det OK ifall vi spelar in denna intervju?

Förklaring på hybrid

- När spelare sitter i samma lokal och använder dator/mobil för att spela
- När spelare sitter på olika (eller på samma plats) platser och använder dator/mobil samt fysiskt schackbräde

Demografiska frågor:

- Ålder
 - Kön
 - Hur länge har du spelat schack?
 - Spelar du någonsin du någonsin hybrid schack?
 - Vad är dina erfarenheter med hybrid schack?
- OM INTE - Spelar du online schack, och vad är dina erfarenheter med det?

1. Vad tycker du är de största skillnaderna med att spela schack online vs offline vs. hybrid?

- Vad tycker du saknas när du spelar online/hybrid?

2. Vilka fysiska aspekter tycker du är viktiga i schack?

- Vad tycker du saknas av det fysiska när du spelar online/hybrid?

3. Vilka sociala aspekter tycker du är viktiga när du spelar schack? (Om du anser att sociala aspekter är viktiga)

- Vad tycker du saknas av det sociala när du spelar online/hybrid?

4. Vad känner du när du spelar schack?

- Hur skiljer det sig när du spelar online/hybrid?

5. Från tidigare observationer har vi sett att vissa spelare gillar att hålla en diskussion/analys efter and under schackmatchen - är detta något du också har upplevt? Berätta gärna mer om din upplevelse i sådana fall.

6. Från tidigare observationer har vi kommit fram till följande aspekter som deltagarna tyckte var viktiga:

7. Finns det förbättringsområden inom någon av dessa spel aspekter?

Appendix 2: Pre-research observations + interview

After activity interview:

- What are the main differences between online and offline chess?
- Do you feel like this was an immersive activity?
- What physical aspects do you use?
Were there any emotions that were brought up while playing?

Appendix 3: Consent form

Interview Consent Form

Purpose

This is a research study conducted as a part of a course project for students studying master's in Human-Computer Interaction at Uppsala University. You have been invited to take part in this study as a member of Uppsala Skolschacksällskap. The purpose of this interview is to hear the perspective of the chess players playing professional games in offline and hybrid setups. The information from this study will help us to improve the experience of the player while playing hybrid chess games.

Procedure

During this study, you will take part in an interview, answering and discussing some questions. The moderator will be responsible for facilitating the session and asking questions. With this study, we would like to discover the many viewpoints on the research subject and therefore there are no right or wrong answers.

Confidentiality

This session will be recorded and an observer will be present to take notes, to ensure the accuracy of the results. However, your responses will be anonymized and all personal data will remain confidential. The final report shall not include any names or other data that could be traced back to you. The data will be stored securely and access will be restricted to the team members. The data will only be used for research purposes and all personal data will be removed at the end of the study in accordance with Article 17 §1.a of the GDPR (i.e., Right to Erasure). As a participant in this study, you are free to opt out at any moment and/or have your data removed from being used in the study.

When you choose to participate, please respect the privacy of the other participants in this focus group by not disclosing any confidential and personal information that is discussed during the session.

Contact

If you have further questions, concerns, or would like to have your data removed from the study, please contact:

Noak Petersson

noak.petersson.8166@student.uu.se

I hereby declare that I understand the given information and agree to participate in the study

Name: _____ Date: _____

Signature:

Appendix 4: Testing 1 & 2 questions

1. Do you think this design would enhance the social connectedness between the players? If yes then how?
2. What elements do you think would have created a better social interaction in this situation? What is missing?
3. Would this prototype potentially change your experience of chess in a positive or negative way?
4. In this design solution the opponent's pieces will move automatically while you reflect. How do you think this would impact the social aspects of the reflection?

Appendix 5: Testing 3 questions

1. Do you think the prototype helped in your ability to reflect the round with your opponent?
2. What aspects of this design enhances the post-game reflection between the players?
How?
3. What do you feel could have been improved in terms of social interaction? What is missing?
4. Do these prototypes change your experience in a negative or positive way?

Appendix 6: Testing 3 interview questions

1. Finns det några funktioner som sticker ut, på bra eller dåligt sätt?
2. Anser du att denna prototyp möjliggör för bra kommunikation mellan spelarna? På vilket sätt?
3. Anser du att denna prototyp möjliggör social interaktion mellan spelare? På vilket sätt?
4. Ändrar detta potentiellt något på din schack upplevelse på ett negativt sätt? Eller på ett positivt sätt?
5. Tycker du att man skulle kunna förbättra kommunikationen & det sociala mellan spelarna på något sätt? Om ja, hur?
6. Har du några preferenser när det kommer till material på schackbräde och pjäser? Spelar det någon roll vilket material som du spelar med? Trä, plast, glas etc.?

Translated questions

1. Do you think there are any features that stand out, in a good or bad way?
2. Do you believe that this prototype enables good communication between the players? If yes, how?
3. Do you believe that this prototype enables social interaction between the players? If yes, how?
4. Would this prototype potentially change your experience of chess in a positive or negative way?
5. Do you believe that we could improve the communication and the social aspects between the players somehow? If yes, how?
6. Do you have any personal preferences when it comes to the material for the chessboard and the pieces?

Appendix 7: Questions for final evaluation

- Thinking about social aspects.
 - Did you feel socially connected with your opponent? How so?
 - How has this setup improved upon social connectedness (compared with normal hybrid-online chess)?
 - In your own words, how did this setup aid you in reflecting with the other player?
 - Do you feel like this setup changed how you experience a post-game analysis session?
- What do you think can be improved on the prototype in the area of social connectedness?