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Assessing Accessibility in Tabletop Games for Inclusive Museum Experiences

Enhancing Tabletop Game Accessibility in Museums: Solutions and Guidelines for Inclusive Exhibitions

Master's thesis in Computer science and engineering

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Abstract

This research explores tabletop game accessibility in a museum setting, specifically for the "A World of Games" exhibition at Världskulturmuseet. The study began with an evaluation of the games on display, followed by a user study to identify accessibility challenges for visitors. Based on the results, we developed solutions aimed at making the games more inclusive, particularly for blind individuals and young children. One key solution was an image recognition app for the game Mekuri, designed to help players with colour blindness and cognitive impairments. A second round of testing was carried out to assess the effectiveness of these solutions. The research led to the creation of guidelines for making board games in museum exhibitions more accessible. These guidelines are meant to benefit not only future exhibitions at Världskulturmuseet but also other teams working on similar projects. While teams like *Meeple Like Us* have made important contributions to board game accessibility, this research focuses specifically on the unique challenges of game exhibitions, where factors such as game length, waiting activities, lighting, and space layout need to be considered. The solutions we offer aim to make the museum experience more inclusive for everyone, regardless of ability. Finally, the study outlines future directions for expanding and refining these accessibility solutions.

Keywords: Accessibility, Game, Game Design, Game Exhibition, Inclusive Design, Museum Accessibility, Pattern Recognition, Project, Tabletop Game Accessibility, Thesis.

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CHRISTOS STYLIANOS VAZOURAS & XIANGYU ZHU, Gothenburg, 2025-08-05

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Introduction

Accessibility is the degree to which a product, service, or environment can be used by as many people as possible, regardless of their abilities, disabilities, or preferences[1]. Accessibility is especially important to consider in board games, as they are a form of entertainment, education, and social interaction that can benefit people of all ages, backgrounds, and cultures. However, many board games are designed with implicit assumptions about the players' physical, cognitive, and sensory abilities, which can create barriers and exclude potential players from enjoying the game. For example, some board games may rely on colour perception, fine motor skills, or verbal communication, which can pose challenges for players who are colour-blind, have limited dexterity, or are deaf or hard of hearing [2].

Accessibility in public spaces is a fundamental aspect of modern urban design. It is the key to creating inclusive communities that welcome everyone, regardless of their physical abilities or age. The concept of accessibility goes beyond just providing physical access. It encompasses the design of products, devices, services, or environments to make them accessible to people with disabilities [3]. The study of this paper is conducted in a games exhibition within a museum. Accessibility considerations can be impacted or compounded when playing board games in public settings, due to environmental factors such as the intensity of the light, as well as the constraints of time and space. Our research will focus on accessibility in such settings.

1.1 Context

In a game exhibition at the museum with plenty of board games, accessibility is particularly important to consider as it can enhance the visitor experience, increase the reach and impact of the exhibition, and promote the museum's social responsibility and reputation. A game exhibition at the museum can be a great opportunity to show the history, culture, and diversity of board games, as well as to engage the visitors in playful and interactive learning. However, if the board games are not accessible, the visitors may encounter frustration, confusion, or exclusion, which can negatively affect their enjoyment and satisfaction. Moreover, the museum might miss the chance to attract and retain a wider and more diverse array of visitors, and to fulfil its mission of serving the public and contributing to the common good. Therefore, it is crucial to ensure that the board games in the exhibition are accessi-

ble, and the museum provides adequate support and accommodation for the visitors with different abilities, needs, and preferences. By doing so, the museum can create a more inclusive, welcoming, and enriching environment for all.

1.2 Aim

This paper reports on a collaboration with the Museum of World Culture, specifically within the A World of Game exhibition. The primary objective was to collect data from participants to understand the accessibility of reinterpreted ancient board games. The aim of this research is to explore and address the accessibility challenges in playing the reinterpreted board games at the exhibition. The study investigates aspects such as the comprehensibility of instructions, easy-to-understand board game symbols, and the influence of historical elements. The study also examines how people interact with the games and whether their engagement is relevant or not for the technological fields. The ultimate goal was to contribute to enhancing the overall experience of visitors interacting with board games in the museum environment. The research results are distinctly unique due to the inherent constraints, such as limited time, space, and resources at the museum. Unlike studies conducted in more casual settings like homes and game halls, the findings are likely to reflect the specific challenges and opportunities posed by the museum environment.

1.3 Research Question

What should be considered when reinterpreting ancient games in a museum environment, in order to maximise inclusive and interactive experiences?

This research explores the key factors involved in adapting historical tabletop games for museum exhibitions while prioritising accessibility. It focuses on balancing authentic representation with practical design solutions that welcome diverse visitors, including those with disabilities, different age groups, and varied learning preferences. Ultimately, we are examining how museums can transform ancient games into meaningful participatory encounters without losing their historical authenticity.

Its important to acknowledge that our study focuses on museum exhibitions as places where people can learn and play, which brings limitations that would not otherwise exist if we studied how, for example, these games could be adapted for a better experience when playing at home.

2

Background

This section outlines the background and rules of tabletop games showcased and the related research in game/tabletop game accessibility and exhibition design.

2.1 Overview of Ancient Board Games Selection

There are many modified copies of ancient tabletop games presented at the exhibition for visitors to play. We chose seven among them for the purpose of this study. The chosen games are Chaturaji, Mekuri, Huuchuish, Ganjifa, Weiqi/Go, Shagai and Senet. Here is an overview of each game: we will cover only the names and origins. Detailed descriptions, rules, and analyses can be found in the execution chapter.

2.1.1 Chaturaji

Chaturaji is a game for four players that has its origins in India. It is similar to Chaturanga, which is considered the first Chess-type game. Dice are used to determine which piece is moved. Several texts give many details of the game, but are not sufficient to provide all of the rules [4].

Figure 2.1: Chaturaji

There are no clear and definite records of Chaturaji's origins or rules; therefore, it's impossible to know how the early Indians played it. Many historians claim

that it was likely a game of chance, with players throwing dice to determine which pieces would move. Additionally, most agree that there were many different rules for Chaturaji instead of one standard way of playing it. The version of Chaturaji that is playable in the exhibition consists of an 8-by-8 squares board, and is designed for 2 to 4 players [4]. There are two dice and four sets of coloured pieces (red, green, blue, yellow), one for each player, and each set consists of four pawns, one king, one horse, one elephant and one ship. Each piece is worth an amount of points, which is engraved on it. Players place the pieces on the board according to the markings on the squares. For example, each horse is places on the square with a horse symbol. Pieces move as follows:

- Pawns can move one square forward, and capture one square forward diagonally.
- The horse moves two squares vertically and one square horizontally, or two squares horizontally and one square vertically, jumping over other pieces, similarly to a knight in Chess.
- The elephant moves any squares vertically, or horizontally.
- The king moves only one square vertically, or horizontally.

Figure 2.2: Playable version of Chaturaji at the museum

Players decide who starts and then the first player throws the two dice, which determine which pieces they can move. In some versions, the dice have numbers which represent a piece. But in the exhibition version, the dice have symbols of the pieces. It is up to the players to decide who starts first.

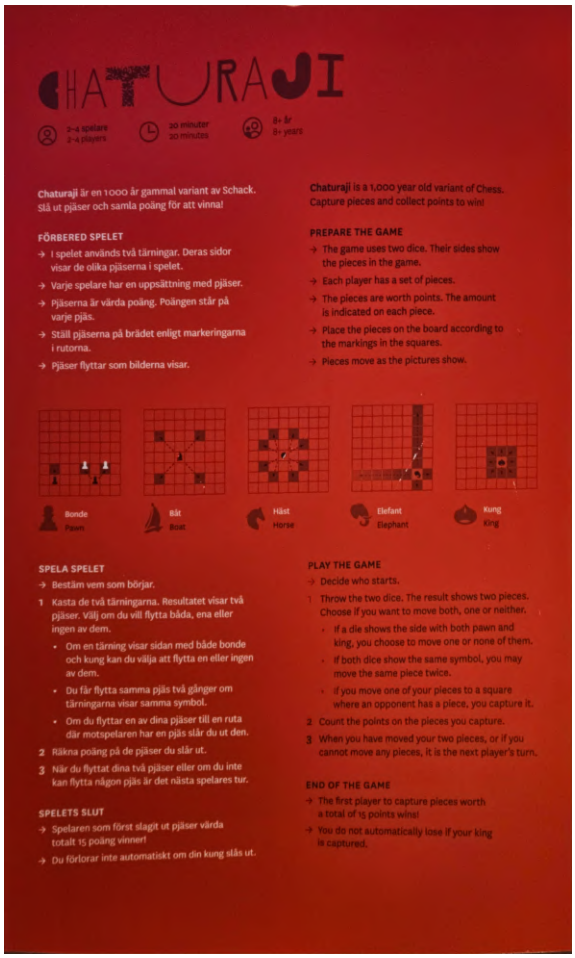

Figure 2.3: Chaturaji rules at the museum

- The first player throws the two dice and can move accordingly. The player can move both pieces, one or neither.
  - If a die shows the side with both pawn and king, they can either move or none of them.
  - If both dice show the same symbol, they can move the same piece twice.
  - If they move one of their pieces to a square where an opponent has a piece, they capture it.
- Then they count the points on the pieces they have captured.
- If they have moved their two pieces or if they cannot move any pieces, it is the next player's turn.
- The first player to capture pieces worth a total of 15 points, wins the game.
- Unlike similar games, like chess, a player does not automatically lose if their king is captured.

2.1.2 Mekuri

Mekurifuda, also known as the Mekuri cards, are a type of Japanese playing cards derived from Portuguese cards in the 16th century. They have four suits: clubs, swords, cups, and coins, and 12 ranks: dragon, 2, 3, 4, 5, 6, 7, 8, 9, maid, horse, and king. Some decks also include a joker card called Onifuda or Bakefuda. Mekurifuda can be used to play various games, such as Mekuri, Oicho-Kabu, Hachi, and Yomi. The game presented at this exhibition is Mekuri [5].

Figure 2.4: Mekuri

Mekuri is a fishing game for 3-4 players. The objective of the game is to capture cards from the field by matching them with cards from the hand or the draw pile [6].

Figure 2.5: Playable version of Mekuri at the museum

The game is played in rounds, and each round consists of four phases: dealing, drawing, capturing, and scoring. The player with the most points at the end of the game wins. In the original rules of Mekuri [7]:

- Each player gets 8 cards, the rest are the draw pile.

- Take turns drawing a card and capturing a matching card from the field, or adding it to the field.
- After the draw pile is empty, play cards from your hand and capture matching cards from the field, or leave them on the field.
- Score points by total of captured card points minus 240.
- Negative score means you lose those points; Positive score means you win those points. The player who earned most points in that round wins and becomes the dealer for the next round.

Figure 2.6: Mekuri rules at the museum

At the museum, the rank on Mekurifuda (the Mekuri cards) has been modified. Dragon, maid, horse, and king were replaced by numbers 1, 10, 11, 12, and the numbers were written at the top of the card using Kanji (They were placed either in the top-right corner, top-left corner, or the middle as shown in Figure 2.7).

Figure 2.7: Random placement of the score

The rules of Mekuri remain mostly the same as its original version, but how points are counted is totally different. Instead of using different suits to distinguish the cards, the museum version gives a colour from white, red, blue, black, and black with a silver ring to each card, and they all worth different points, as shown at the bottom of Figure 2.6. The player needs to add the points on the cards they have in hand together, and the one with the most points wins.

2.1.3 Huuchuish

Huuchuish is a game from Central California, North America. Even though the exact rules for Huuchuish are unclear, sources agree that it was a game played by native American women, such as the Yokuts, in what is modern-day California. The gambling basket or tray, sometimes decorated in motifs, is woven, and players throw dice made of nuts (usually walnuts) on it and use wooden sticks to keep score [8, 9].

Figure 2.8: Huuchuish

The exact rules of Huuchuish remain unclear, but it is known to be a gambling game. In the version displayed at the museum [10], to play the game, players must first prepare it as follows:

- There should be eight walnuts in the basket.

- A walnut can land with the inside or outside face up. The number of dots on them have no meaning for the game.
- If there are two players, they have to decide which one is ‘even’ and which one is ‘odd’. Similarly if there more than two players, they have to split in two teams and decide which team is ‘even’ and which is ‘odd’.

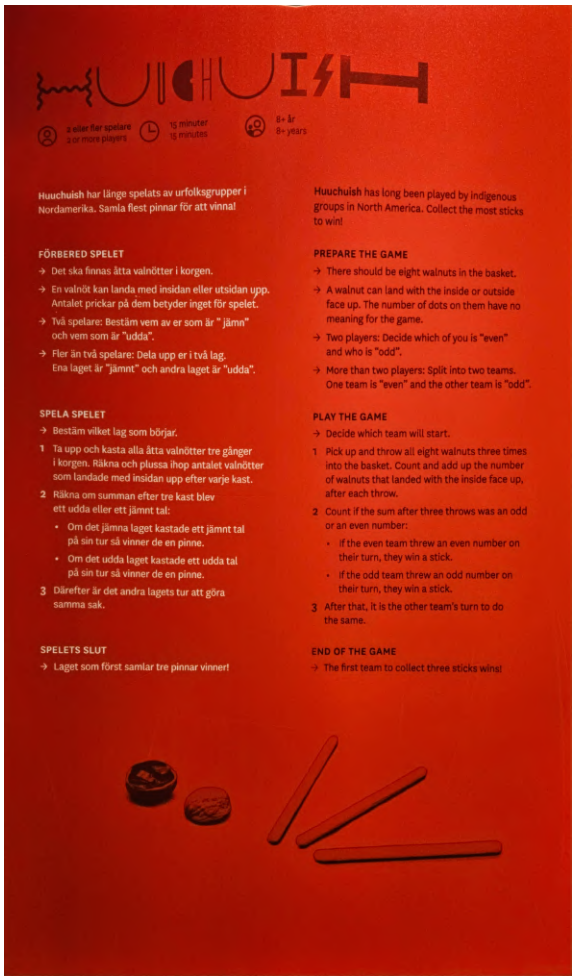

Figure 2.9: Huuchuish rules at the museum

The players then decide who starts first. For the sake of simplicity we’ll use the term ‘team’ whether it refers to one player or a team of more players.

- The first team picks up all the walnuts and throws them in the basket three times. After each throw, they count and add up the number of walnuts that landed with the inside face up.
- Count the sum after the three throws.
  - If the ‘even’ team threw an even number on their turn, they win a stick.
  - If the ‘even’ team threw an odd number on their turn, nothing happens.
  - If the ‘odd’ team threw an odd number on their turn, they win a stick.

  - If the 'odd' team threw an even number on their turn, nothing happens.

- After that, it is the other team's turn to do the same.
- The first team to win three sticks, wins the game.

2.1.4 Ganjifa

Ganjifa is a card game that originated in Persia and became popular in India in the 16th century. The name Ganjifa comes from the Persian word ganj, meaning treasure or money. The game has several variations across West, Central and South Asia, each with a distinct iconography, deck and cultural context. The cards are circular or rectangular, and traditionally hand-painted by artisans. [11]

Figure 2.10: Ganjifa

The rules of Ganjifa are largely consistent across its various versions [12]. A game typically has three players and lasts three rounds, although this can be adjusted if required. The most common version is the Mughal Ganjifa, which has 96 cards in 8 suits of 12 cards each. Each suit has two court cards (king and vizier) and ten pip cards (from 1 to 10) [13, 14].

- The dealer shuffles the cards and deals them all to the players, face down. The player to the dealers right starts the first trick by playing any card. The other players must follow suit if they can, or play any other card otherwise. The trick is won by the highest card of the suit led, or the highest court card if more than one suit is played. The winner of the trick leads the next one.
- The round ends when all the cards are played. The player with the most cards wins the round and scores one point. The player with the least cards loses the round and must exchange some of their high cards for the other players low cards in the next round. The number of cards exchanged depends on the number of tricks lost.
- The game ends after three rounds. The player with the most points wins the game. If there is a tie, the player with the most cards in the last round wins.

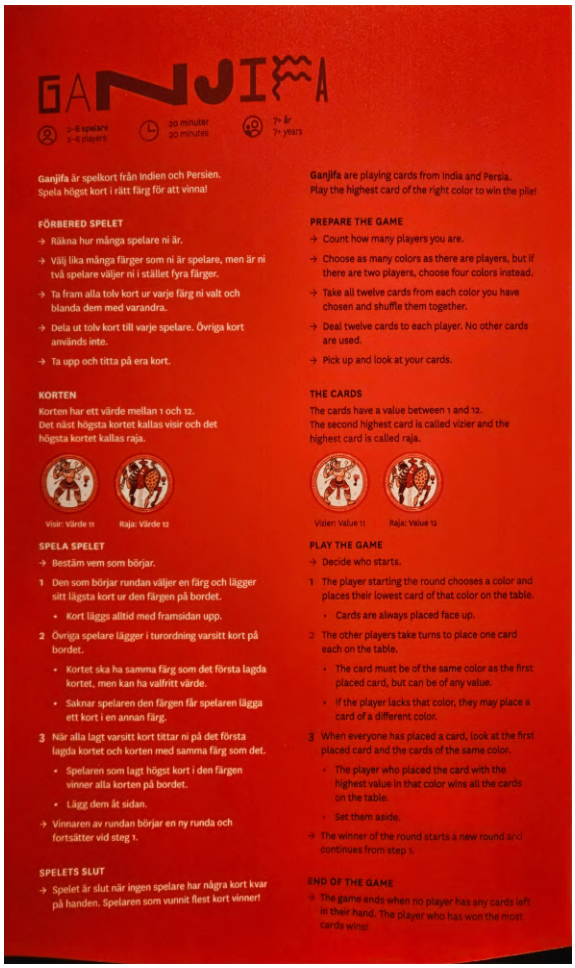

Figure 2.11: Ganjifa rules at the museum

2.1.5 Weiqi/Go

Weiqi, also known as Go, is an ancient Chinese board game of strategy and balance. Its played on a 19x19 grid where two players alternate placing black or white stones with the aim to surround more territory than the opponent. The game reflects the Taoist concept of Yin and Yang and the Confucian ideals of propriety and fairness. Weiqis complexity is so vast that the number of possible games exceeds the number of atoms in the observable universe [15].

Figure 2.12: Weiqi/Go

Weiqi is a game with roots in China for two players, who take turns placing black and white stones on the intersections of the squares of a board, aiming to control territory and capture their opponent's stones. The goal is to control more territory than your opponent by strategically placing stones on the board.

- The players decide who has the white stones and who the black ones.
- The board is empty at the start of the game.
- The player who has the black stones begins to place one stone on the board. As mentioned before, stones are placed at intersections between squares.
- The players take turns placing stones at the board.
- When a player surrounds one of their opponent's stones, they remove it from the board.
- When a player surrounds multiple of their opponent's stones which are placed next to each other, they remove all of them from the board.
- A player cannot place a stone on an empty intersection that is already surrounded by the opponent's stones. If however, that stone immediately helps to remove one or more of the opponent's stones, then it is allowed.
- The game ends when both players agree that there are no more beneficial moves to be made. At this point, the score is calculated based on the controlled territories and captured stones.
- The player with the most controlled territory and captured stones wins the game.

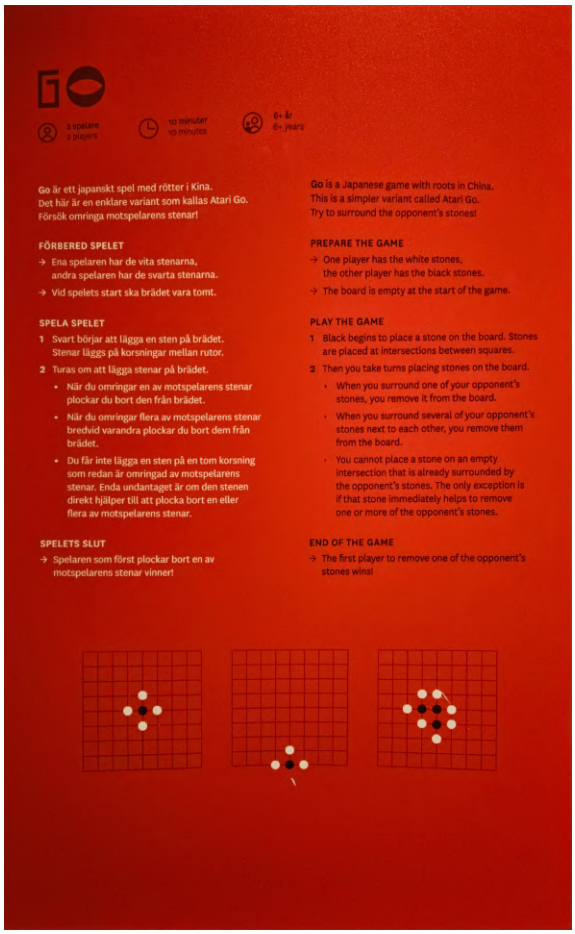

Figure 2.13: Weiqi rules at the museum

At the museum, they opted for a more dynamic and fast-paced variation of Atari-Go, enhancing the traditional gameplay with an exciting twist. While players continue to take turns strategically placing their stones on the board, the conditions for victory have been streamlined: success is now achieved by capturing just one of the opponent's stones [16]. This thrilling adaptation injects a heightened sense of urgency and intensity into each move, demanding quick thinking and precise execution.

To further emphasise the excitement, the game board has been intentionally reduced to a 13x13 grid, creating a more condensed and action-packed experience. This smaller playing field not only speeds up the game but also encourages more direct confrontations and tactical depth, making every placement of a stone critical to the outcome. The museum's choice to implement these modifications transforms the classic game into a gripping challenge that captivates both seasoned players and newcomers alike.

2.1.6 Shagai

The word shagai refers to the astragalus of the ankle of a sheep or goat. These bones are collected and used for a large variety of traditional games and fortune

telling in Central Asia, and especially Mongolia. There is a large variety of games played using shagai, like the one in the Museum of World Culture, and they have been played for thousands of years, and continues to be played today. [17, 18].

Figure 2.14: Shagai

One of the many games of the Shagai family is the one presented in the museum. There are 30 coloured shagai on the table. However, they are coloured only for decorative purposes, as their colours do not affect the game. A shagai has four sides. Each side symbolises and is named after an animal: 'goat', 'horse', 'camel', 'sheep' [17, 18].

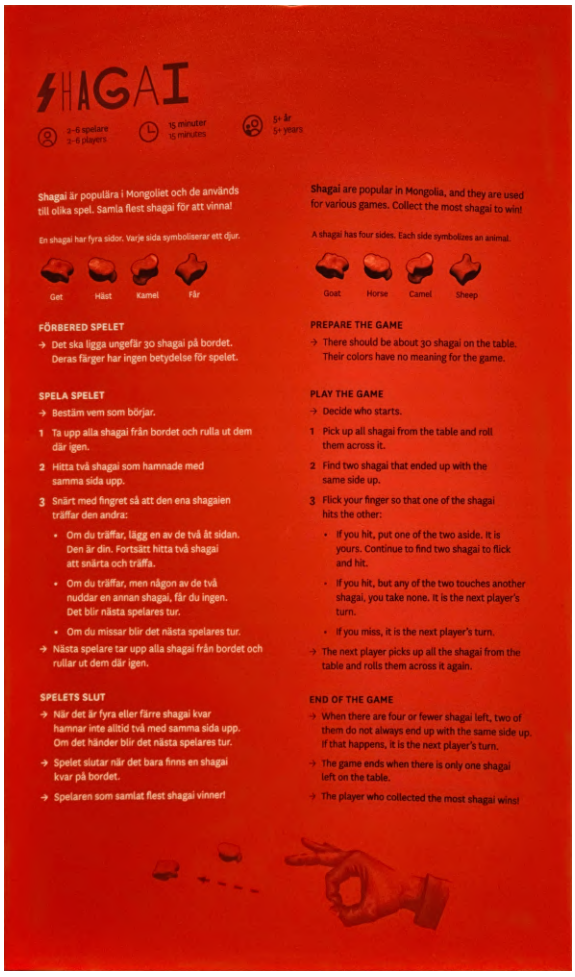

Figure 2.15: Shagai rules at the museum

- The players decide who starts and the first player picks up the shagai and tosses them them on the table.
- Then the player must find two shagai that landed on the same side.
- They flick their fingers, trying to make one shagai hit the other.
  - If the one shagai hits the other, the player chooses one of the two and puts it aside. Then continues, and find another couple of shagai that landed on the same side and tries to hit one with the other again. The next couple of shagai does not have to be on the same side as the first couple.
  - If the shagai hits the other, but it also touches another shagai, then the player takes none. And then it is the next player's turn.
  - If the player misses, then again they take none and is the next player's turn.
- The next players picks up the remaining shagai (which means not the ones possibly put aside) and tosses them on the table too, following the same process.

- When there are four or fewer shagai left, it is possible that there is no pair that landed on the same side. If this happens, then it is the other player's turn.

- The game ends when there is only one shagai left on the table.

- The players count how many shagai they have collected and the one who has the most wins the game.

2.1.7 Senet

Senet is a board game from ancient Egypt and is considered one of the oldest games in the world, dating back to 2620 BCE [19]. A complete set of rules has not been found but archaeologists use texts and paintings found in tombs to understand how the game was most probably played. The board and the pieces racing from the start to the end of it represent the journey through afterlife, which was very important in ancient Egyptian culture. For this reason, Senet has a great religious value.

Figure 2.16: Senet

Senet is an ancient Egyptian game for two players. The exact rules of the game are not known, but the rules for the version in the museum are the following [20].

The players decide who will play with the blue pieces and who with the light brown pieces. Then they place all ten pieces on the starting squares, and decide who starts first.

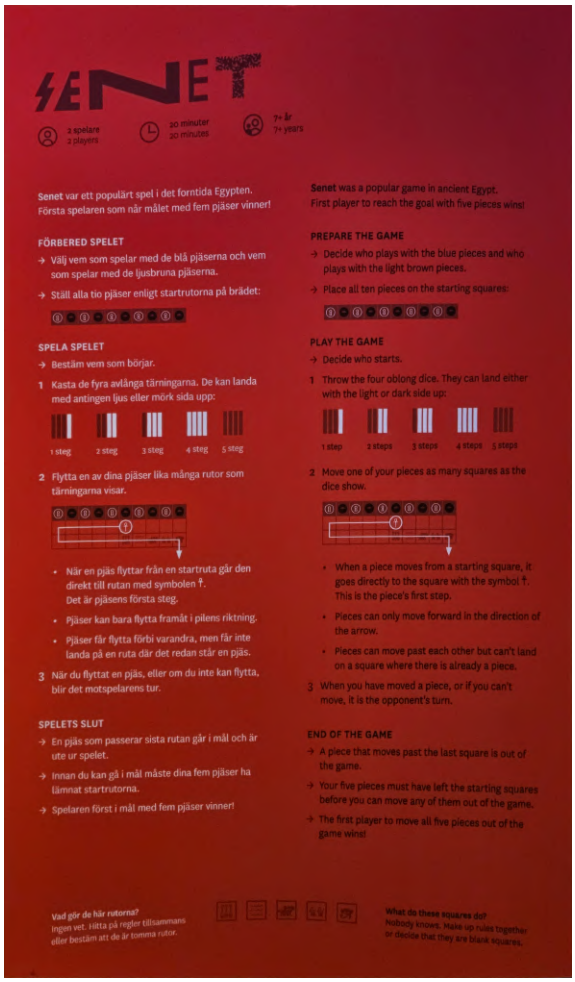

Figure 2.17: Senet rules at the museum

- The first player throws the four oblong dice, which can land with either the light or dark side up.
  - If only one die lands with the light side up, then the player can move one piece one step forward.
  - If two dice land with the light side up, then the player can move one piece two steps forward.
  - If three dice land with the light side up, then the player can move one piece three steps forward.
  - If four dice land with the light side up, then the player can move one piece four steps forward.
  - If four dice land with the dark side up, then the player can move one piece five steps forward.

  It is then the other player's turn. The pieces move along the path indicated in the rules board, starting form the middle of the first row, moving towards the left and then to the second row.

- When a piece moves from its starting square, it goes directly to the square with the 'Ankh' symbol. This is the piece's first step.
- Pieces can only move forward in the direction of the arrow in the rules board (as described above).
- Pieces can move past each other but cannot land on a square where a piece is already placed.
- A piece that moves past the last square is out of the game.
- Before a player can move any of their pieces out of the game, all their pieces must have left the starting squares.
- The first player to move all five of their pieces out of the game, wins.
- The last five squares have certain symbols on them. It is up to the players to decide what they mean and how they affect the game.

2.2 Related work

In the field of board game design, there is a gap in research regarding the creation of board games for exhibition spaces. Although there is information on making games more accessible, there has been little focus on designing accessible games specifically for exhibitions. We have not encountered any previous work that discusses the accessibility issues involved in crafting board games for display in these unique environments. This section introduces the current related work that can support our studies.

2.2.1 Why do we consider accessibility in board games?

The importance of accessible board games is well-documented in academic literature, which emphasises their role in encouraging inclusive play, enhancing learning, and supporting cognitive development. Bayeck highlights that board games are not merely for entertainment but also serve as dynamic learning environments where players can develop skills such as computational thinking and creativity [21]. This aligns with the broader educational perspective that games can simplify complex systems, making them ideal for teaching and exploring concepts like motivation in both formal and informal educational settings

Moreover, the cooperative nature of many board games is noted to contribute positively to learning outcomes. Lai et al. found that game-based cooperative learning can improve students learning and motivation, supporting the idea that games can facilitate knowledge retention and collaborative learning approaches [22]. This is particularly relevant for board games, which often require players to work together to achieve common goals, thereby promoting social interaction and teamwork.

Accessibility in board games extends to accommodating diverse needs, ensuring that individuals with various disabilities can participate equally. Research indicates that accessible board games can provide valuable opportunities for socialisation, learning,

and engagement for people with disabilities, contributing to a more inclusive gaming culture [23]. By designing board games with accessibility in mind, creators can ensure that these benefits are available to more players, regardless of their physical or cognitive abilities.

2.2.2 Temporary Disability and Board Game Accessibility

A temporary disability can be defined as a disability that affects you for a short period of time. These conditions usually keep people incapacitated or out of work for a few days, weeks, months, or years but typically result in the eventual recovery. This type of disability often includes illnesses or injuries that temporarily prohibit people from participating in daily routine activities, it can significantly impact an individuals ability to engage in various activities, including playing board games[24]. These disabilities can range from impaired mobility or dexterity to visual and cognitive challenges, necessitating the need for accessible game design.

Board games traditionally involve physical components and rely on visual cues, which can pose barriers to those with temporary disabilities. To address this, game designers are exploring innovative solutions to enhance accessibility. This includes creating games with tactile components, audio descriptions, and adaptable rules that cater to a variety of needs.

The conversation around accessibility in gaming is growing, with advocates emphasising the importance of inclusive design. ABILITY Magazine [25], for instance, highlights the efforts of the gaming industry, including Microsofts Xbox team, to improve the gaming experience for people with disabilities. This push towards inclusivity is not just about permanent disabilities; it also encompasses the needs of those with temporary conditions, ensuring that everyone has the opportunity to enjoy gaming.

Incorporating accessibility features into board games not only benefits individuals with temporary disabilities but also enhances the overall gaming experience for all players. By considering the diverse needs of players, designers can create games that are more engaging, flexible, and inclusive.

2.2.3 Designing Accessible Exhibitions

Some institutions have already attempted to design accessible exhibitions, some times focusing on a certain type of disabilities, and others having a larger scope. Different methods have been used in different cases and with different actors. This section will examine some of these attempts, in order to gain a better understanding on the processes and the results.

2.2.3.1 Bendigo Art Gallery, Australia

The Bendigo Art Gallery in Bendigo, Australia, focused on making their exhibitions accessible to specific groups of people; in this case people who are Blind or have Low Vision (BLV) [26]. They followed a Research Through Design method.

They worked on two exhibitions, which were held twelve months apart. This allowed an iterative approach, meaning lessons from the first exhibition could be applied in the second.

They first looked into previous related work carried out by other institutions. Later, they hosted workshops with a diverse group of researchers in order to create accessible artefacts for the first exhibition. Finally, they evaluated the results through interviews with four BLV visitors and three Bendigo Art Gallery employees.
A similar process was followed for the second exhibition, with design workshops taking place first, this time with the outcomes of the first one in mind. The evaluation was carried out with thirty six BLV visitors, and interviews with eight of them and one gallery employee.
In the end, they created a framework, with a set of principles, for creating inclusive gallery experiences.

While the nature of this exhibition and its content is different from the 'A World of Games' exhibition in the Museum of World Culture, the process followed in order to increase accessibility is interesting and could provide a framework for our work. Following a similar order of their work steps sounds reasonable, and more specifically an iterative process. In our case, however, we only focus on one exhibition, so the iteration would have to do with different versions of the board games, and not two different exhibitions.

2.2.3.2 National Centre for Craft & Design, United Kingdom

The National Centre for Craft & Design (NCCD) in Sleaford, UK, also focused on people with a visual impairment (VIP), but followed a different approach. They instead used methods of participatory design in order to co-create an accessible, multi-sensory exhibition [27].

Working together with NNCD employees and creating a Creative Lab group with VIP, a representative from the Royal British Institute for Blind People, the head of exhibition and the author. The project was divided in two stages. In the first one, workshops which consisted of only a small number of people took place. The small number increased participation. During the sessions, the participants set the main topics and issues to be addressed. In the second stage, an evaluation of the co-creation process was made, and a future case study would be developed regarding the improvement of how NCCD meets the needs of VIP.

The end result included creating accessible graphics (walls and object labels), paths, interactive desks, and plinths with exhibits on them that allowed the visitors to view the exhibits from at least three sides.

2.2.3.3 Sakip Sabanci Museum, Turkey

This study examines how three museums (Sakip Sabanci Museum, Istanbul Modern, Pera Museum) in Istanbul deal with designing accessible exhibitions [28]. However, it concludes that while all three museums are physically accessible, only the Sakip Sabanci Museum tries to make their content accessible to people who are blind or

have low vision. The museum does so only for major exhibitions, in which it provides touch and audio descriptive tours, supported by the use of braille for artworks, texts, and labels.

The main reasons cited by the other two museums were the limited resources and the high number of visitors. However, museums with a larger number of visitors have made attempts to make their exhibitions more accessible. They also stated that people with disabilities prefer dedicated tours adapted to them. For example, the Istanbul Modern is carrying out a programme named "We Meet" for children with learning disabilities.

2.2.3.4 The Interactive Museum Lab in Kulturfabriken, Sweden

This project focuses on how museums use new technologies and how people with disabilities can be included when developing a new product [29]. In that sense it combines accessibility design for digital products and physical spaces, and specifically museum settings. In this case the product is an interactive lab inside the Kulturfabriken museum in Skövde. One of the methods used when conducting this research was interviews with people, each one from a different focus group:

1. A person who needs a wheelchair every day.
2. A person who leads a project that aims to promote health, leisure and social participation for people who have a cognitive disability, using music.
3. A person who is highly deaf impaired and 90% visually impaired and president of the Swedish 'Visually Impaired Association'.
4. A person who is the president of the Swedish 'For children, youth and adults with developmental disabilities' organisation.
5. A person who works as personal assistant to people with disabilities.

These interviews provided the researchers with different perspectives and aided in creating a list of things to consider when designing the interactive lab, such as avoiding the use of stairs, creating enough space around the objects, creating objects that are easy to move so that the physical space is more accessible. Having an always available Wi-Fi connections to make information available was also mentioned.

Using the 'Smithsonian Guidelines for Accessible Exhibition Design' [30], the researchers calculated measurements for the design of the physical space of the museum.

2.2.4 Algorithms used for Pattern detection

For image recognition, we researched numerous past projects online and watched many tutorials on image recognition. Ultimately, we identified a direction and decided to use ORB (Oriented FAST and Rotated BRIEF) combined with FLANN-based matching to implement our application.

2.2.4.1 ORB (Oriented FAST and Rotated BRIEF)

Oriented FAST and Rotated BRIEF (ORB) is a feature detector and descriptor that is widely used in computer vision applications for pattern detection. It combines the speed of the FAST (Features from Accelerated Segment Test) detector with the robustness of the BRIEF (Binary Robust Independent Elementary Features) descriptor. The ORB algorithm first detects key points in an image using the FAST method, which identifies corners by examining a circle of pixels around a candidate point. These key points are then oriented to ensure rotation invariance, and a binary descriptor is generated using the BRIEF method, which compares pixel intensities in pairs to create a binary string representing the key point. The result is a fast and efficient method for feature matching that is invariant to rotation and robust to noise, making it suitable for real-time applications [31].

2.2.4.2 FLANN-based matching

FLANN-based matching (Fast Library for Approximate Nearest Neighbors) is a powerful algorithm used in computer vision for efficiently finding the best matches between two sets of features in images. Unlike traditional brute-force matching, which compares each feature in one set to every feature in another set, FLANN uses approximate nearest neighbour search to significantly speed up the process. This makes it particularly useful for real-time applications where computational efficiency is crucial. FLANN-based matching is often used with feature descriptors like SIFT, SURF, ORB, and BRIEF, and it supports various distance metrics such as Euclidean distance and Hamming distance. By leveraging multi-dimensional clustering and search techniques, FLANN ensures robust and accurate feature matching, even in large-scale image datasets [32].

When combined, ORB helps detect and describe key points in images, while FLANN-based matching allows the app to efficiently compare and match those points, enabling robust and fast image recognition. This combination is especially useful in applications like object detection, pattern recognition, and tracking, where recognizing and matching distinctive features across different images is crucial.

Summary

A lot can be learned by the attempts of other researchers and institutions to create accessible exhibitions. While each exhibition differs in content and theme, but also the limitations because of space and resources, these works can prove helpful in our research, but in different ways. In the work by the Bendigo Art Gallery, the process followed is more important than the findings and the results, while for the National Centre for Craft and Design and the Sakip Sabanci Museum, the end result of creating accessible graphics and interactive content is something we can keep in mind for improving the exhibition in the Museum of World Culture. During the work done with Kulturfabriken and the researcher from the University of Skövde, they conducted interviews with stakeholders, in order to identify problems and possible solutions for them, but also asked more open-ended questions and the stakeholders provided their opinion on how they can improve the Interactive Lab in the museum.

3

Theory

This section presents the theoretical framework that our research is based upon. It involves a discussion of existing theories and literature that directly relate to our studys aims.

3.0.1 Accessibility Tear-down

The article titled *Eighteen Months of Meeple Like Us: An Exploration into the State of Board Game Accessibility*[33] is about accessibility studies on board games. A team of researchers took a close look at 116 different board games. These were not just any games; they were some of the top games from a famous list on BoardGameGeek. The team played each game at least three times. They did this to really understand what makes these games easy or hard to play for people with different needs in terms of accessibility.

Another article written by the same authors titled *Meeple Centred Design: A Heuristic Toolkit for Evaluating the Accessibility of Tabletop Games*[34] introduces a heuristic framework of common accessibility elements for tabletop games. This framework breaks down accessibility issues into a set of categories:

1. Visual impairments, including colour blindness.
2. Cognitive impairments, focusing on fluid and crystallised intelligence.
3. Physical impairments, in both gross and fine-grained motor skills.
4. Communication impairments, relating to the ability to speak, hear or otherwise communicate.
5. Socioeconomic impairments, with regards to cultural inclusion and economic considerations.
6. Intersectional issues, in which particular combinations of impairment may have additional impact.

There are elements that relate to each category within the framework. The research team uses the framework as a basis and gives a letter grade to each game. Numerical values are used to figure out the average and how much the grades vary. Then, plus and minus signs are added to the letter grades (like A+, A, A-) to show small differences. For analysis, these detailed grades are turned into simpler ones shown

in charts. These simple grades are also shown in radar charts, which are easy to look at but not perfect for complex data. The radar charts help match the games features with what people need.

Its also mentioned that this method has limitations. The grades are based on what people without disabilities think, so they might not be completely accurate. To make the grades better, the team asks for feedback from different people, including those with disabilities, through blogs and social media. Changes based on this feedback are recorded. The article also notes that most of the analysis is from the view of a man with no disabilities and a good social position. They want to include more perspectives to make the grades more accurate.

3.1 Universal Design

Universal Design (UD) is a strategic approach to design that aims to create products, environments, and experiences that are accessible to the widest range of people without the need for adaptation or specialised design. [35] Originally conceived by architect Ronald Mace, Universal Design seeks to accommodate individuals of all ages, sizes, and abilities. The seven principles of universal design are: **Equitable use**, **flexibility in use**, **simple and intuitive use**, **perceptible information**, **tolerance for error**, **low physical effort**, and **size and space for approach and use**. It is rooted in the belief that the design of products and environments should be usable by everyone, to the greatest extent possible, without the need to modify or create specialised solutions.

3.1.1 Applying Universal Design to projects

With the integration of UD principles, projects can be inclusive, enhance user experiences, and be successful. The following section provides an overview of how UD has been successfully applied across different fields.

3.1.1.1 Universal Design for Learning (UDL)

Like UD, UDL is all about making courses that work well for every student. Its a way to plan and create courses so that everyone can use them easily and have a good learning experience. This idea is connected to the rights of people with disabilities. UDL is different from making changes for individual students after the fact; its about thinking ahead and making sure the course is ready for all kinds of students from the start. The main goals of UDL are to make sure things are fair and flexible, easy to understand, straightforward to use, provide clear information, allow for mistakes, dont require a lot of effort, and have enough room for everyone. UDL makes the usual way of designing courses better by making sure no one is left out. Even though some people might doubt it can work, UDL actually makes it easier to run a course and helps all students learn better by getting rid of obstacles in a thoughtful and open way. [36]

3.1.1.2 Enabling Village by WOHA in Singapore

A project that has applied UD is the Enabling Village in Singapore. Designed by WOHA, The place provides shops, fun activities, and training for people with disabilities. Every area, including the bathrooms, is easy to go in with a wheelchair. For those who use hearing aids, there are special systems in the event areas that help them hear better. It is also possible to get maps in braille if it is needed. Even the ATM machines there have braille and places to plug in headphones. There is also a special area for people to come up with and try out new tools that help those with disabilities. This area includes a special room where creators can test their inventions without any noise or light distractions. Plus, they are also providing jobs for people with disabilities in the community. [37]

3.1.2 Relevance to Board Game Accessibility in Museums

The principles of Universal Design are particularly pertinent to the study of board game accessibility in museum settings for several reasons [38]:

1. Museums are public spaces that serve diverse populations, including individuals with various disabilities. Applying Universal Design to board games ensures that these educational and interactive exhibits are inclusive, allowing people with disabilities to engage fully alongside their peers.

2. Solutions based on Universal Design are sustainable as they minimise the need for future modifications or the creation of additional versions to accommodate different users. This is economically and operationally beneficial for museums, which often operate under budget constraints and limited resources.

3. Universal Design not only benefits individuals with specific needs but also improves the user experience for all visitors. Features that make games accessible for people with disabilities often enhance the usability for others, such as clear instructions, tactile elements, and simplified engagement methods, which can make the games more appealing and understandable for everyone.

4. Many regions have laws and regulations that require public institutions, including museums, to be accessible. Applying Universal Design principles helps museums comply with these legal requirements and uphold ethical standards of equity and accessibility.

5. Board games in museums often serve an educational purpose. By designing these games to be universally accessible, museums ensure that all visitors, regardless of ability, can learn from and enjoy them, thereby fulfilling their educational mission more effectively.

Therefore, it is important to apply the principles of universal design and inclusive design to board games, in order to create games that are accessible, usable, and enjoyable for the widest possible audience. Universal design is the process of designing products or environments that are usable by all people, to the greatest extent possible, without the need for adaptation or specialised design. Inclusive design is the process of involving people with diverse abilities, needs, and preferences in the design

process, to ensure that their perspectives and experiences are considered and valued. By applying these principles to board games, designers can create games that are more flexible, adaptable, and responsive to the players needs and preferences, as well as more innovative, creative, and diverse.

Universal Design serves as a critical framework for our study, providing a foundation for analysing and improving board game accessibility in museum environments. It supports the goal of creating more inclusive cultural spaces that respect and value diversity in all forms.

3.2 Exhibition Design

Designing board games in such a way that they are accessible to a wide range of people is important. However, the physical space that accommodates the games and the visitors should also be designed with the same goal in mind. Otherwise, unnecessary barriers are created, and the visitors will not be able to play the games, despite their disability-friendly design.

When designing an exhibition or a museum for accessibility, various types of disabilities should be taken into account, in order to anticipate the needs of a greater number of people.

3.2.1 Smithsonian Guidelines for Accessible Exhibition Design, Smithsonian Institution

Various museums and organisations have attempted to make their spaces more accessible or created guidelines for this cause. One of these is the 'Smithsonian Guidelines for Accessible Exhibition Design' [30], a document by the Smithsonian Institution, USA. It is structured by parts that construct the physical space (such as furniture and lighting) and how these can be designed so that they create an accessible environment.

The guidelines and tools section of the document consists of the following 11 subsections:

1. Exhibition Content, which states, among others, that museums should make their content available in more than one sensory channels, such as visual and auditory.
2. Exhibition Items. Special care should be taken so that items are not placed in such a way that could cause damage to visitors. Furthermore, these items that are most important to the exhibitions must be presented in both a kinaesthetic way and/or by auditory description.
3. Label Text and Design. In this section it states that label information must be presented legibly and also in alternative formats, such as Braille or audio.
4. Audiovisuals and Interactives, which states that either open or closed captions should be used for audiovisual material produced by the museum itself, and

also for material produced by third parties, but used by the museum for a period longer than three months. Audiovisuals that do not contain sound should be accompanied by labels that state so, in order for visitors to know they are not missing any information. Both instructions and the means to control interactive items should be accessible to all visitors regardless of their level of ability. Their location should also not create barriers; they should not be blocked by other items and their use should be unhindered for visitors who use any type of assistive devices.

5. Circulation Route, under which it is stated that the circulation route must be adequately illuminated, clearly marked, and easy to navigate.

6. Furniture, which states that exhibition cases should not pose a safety danger to visitors and should be viewable to people of all heights, as well as both people who are standing or seated. Seating should be available in the exhibition, and at least half of it should be accessible.

7. Colour, which states that there should be a high contrast between the text and background on labels.

8. Lighting. Light and colour should create a clearly defined route, for example when there is a change in level (e.g. stairs) or turns or obstacles. The lighting should allow labels to be easily readable and special care should be taken so that there is no glare on cases or labels.

9. Public Programming Spaces. Assistive listening systems should exist in all public programming spaces. Seating in such areas should be designed in such a way that it accommodates a wide range of people, so wheelchair space chairs with and without arms and back, or with adjustable arms should be provided.

10. Emergency Egress, which states, among others, that fully accessible emergency exits should exist throughout the exhibition space, and that both visual and audible fire alarms systems should be provided.

11. Children's Environments, which states that areas for children should follow the requirements by the 'Architectural and Transportation Barriers Compliance Board'.

3.2.2 Exhibitions for All, National Museums of Scotland

The National Museums of Scotland have produced a practical guide that aims to help exhibition planners and designers create accessible exhibitions [39]. The guide is in line with the legal requirements of the Building Regulations and the Disability Discrimination Act. However, it states that these requirements provide a minimum standard and for this reason attempts to embrace the concept of Universal Design.

The guide provides detailed text and visual descriptions, but also reasons for designing these in the described way. It also takes into account that not every person is the same and that providing different choices is important.

Similarly to the Smithsonian Guidelines for Accessible Exhibition Design, the guide is structured by the parts that make up the exhibition space, in the following sections:

1. General and Physical Access, which includes elements such as the doors and entrances, stairs, signage and seating.
2. Display and Communication, which focuses on the graphics, texts, symbols and language used.
3. Audio Visuals and Subtitles, which includes audio-visual elements and subtitles.
4. Lighting, which includes advice regarding the lighting levels, colours, maintenance of them.
5. Further Information, which covers legal and voluntary requirements, and further reading.

Summary

Taking the above into consideration, it is realised that when designing an exhibition space, there are numerous elements which should be considered so that they do not create barriers to visitors. Not only the physical space could stop visitors from experiencing the content of a museum or exhibition, but it could even pose a danger to their health and well-being. Designers should also keep in mind that visitors are people with diverse needs and abilities and that one solution does not always help all people; it may cause a problem for some others.

4

Methods

Our study will be conducted in a series of methodical steps to ensure a comprehensive examination of board game accessibility within exhibition spaces:

1. Research: We will begin by familiarising ourselves with the games selected for analysis, Each game will be evaluated based on its accessibility features. The method we will be using for accessibility evaluation will be based on the framework of Accessibility Tear-down and Universal Design.
2. Data Collection: Through the creation of questionnaires and conducting interviews, we aim to gather detailed data on user experiences and accessibility requirements.
3. Game Selection and Solution Design: Based on the collected data, we will identify three games to concentrate our efforts on and develop tailored solutions that address the players needs.
4. Solution Testing: The proposed solutions will be tested to evaluate their effectiveness in enhancing game accessibility.
5. Feedback Gathering: Further testing will be conducted to collect feedback from a diverse range of participants, ensuring a broad perspective on the solutions impact.
6. Analysis and Discussion: The feedback and data will be meticulously analysed to draw meaningful conclusions about the accessibility improvements.
7. Report Writing: Finally, the findings and insights from our study will be compiled into a comprehensive report, documenting the research process, results, and recommendations for future design considerations.

In addition to the structured steps outlined, our project will be guided by the principles of the Agile Methodology [40]. This approach will allow us to remain flexible and responsive to changes, ensuring continuous improvement and iterative development throughout the course of our research.

4.1 Agile Project Management

The overarching method used to structure our workflow during this research will be Agile Project Management. Agile Project Management derives from the principles

of Agile software development. Agile software development is not a management technique, but a mindset for developing software. However, it can be applied to various fields, other than software development. The 'Manifesto for Agile Software Development' is based on four values [40] and twelve principles [41]. The four values are:

1. **Individuals and interactions over processes and tools**
   While the tools and process used plays a role in the success of a project, the Agile Manifesto states that having the right team members and the way these members work together and cooperate is more important.

2. **Working software over comprehensive documentation**
   Most of the approaches used before Agile, such as the Waterfall model required extensive and comprehensive documentation, in an attempt to cover everything, even before starting to develop the actual software [42, 43]. According to the Agile Manifesto however, it is more efficient to create working software, which is better than documentation for receiving feedback by stakeholders. Creating extensive and detailed documentation could also create unnecessary delays which can prove costly. This may be, for example, because the documentation may cover features which the users do not consider important or useful.

3. **Customer collaboration over contract negotiation**
   Most methods used before Agile Development usually involved the users or customers only in the beginning of the project, where they had to set the requirements, needs and important features of it. These methods do not take take into consideration the stakeholders' feedback during the development, while Agile emphasises its importance and constant feedback.

4. **Responding to change over following a plan**
   As mentioned before, according to Agile, it is not as efficient to creative exhaustive documentation in the beginning and committing to this plan. Instead, the development team should be adaptive and flexible.

It is clearly stated however that this does not mean that processes and tools, comprehensive documentation, contract negotiation and following a plan are not important. It simply means that the individuals and interactions, working software, customer collaboration and responding to change, respectively, are valued more highly.

We believe that using Agile Project Management to structure our work is particularly suitable for our project due to its user-focused approach. One key reason is the importance of continuous collaboration with stakeholders, including museum visitors, museum employees, and university professors, for the success of this project. Whilst methods like the Waterfall model also incorporate user input, they do so at predefined stages and may not allow for the same level of ongoing engagement and flexibility.

Basing our work solely on previously acquired knowledge and theoretical analysis would not be sufficient, as it would exclude the people directly affected by our workthe visitors and employees of the museum. Agile Project Management, with

its iterative and incremental approach, allows us to continuously gather and incorporate feedback from these stakeholders. This ensures that our ideas and plans for improving the exhibition can be adapted based on the feedback received from participants in the questionnaires and interviews we plan to conduct.

Therefore, Agile is favourable to Waterfall and other methods we considered, as it prioritises user engagement and adaptability, which are crucial for the success of our project.

4.2 Data Collection

Data collection will be conducted in two sequential phases using Mixed Methods Researches [44]. This will involve two primary methods: survey and semi-structured interviews:

1. Survey: The data collection will consist of a quantitative survey to capture demographic information, user preferences, and accessibility ratings across various aspects of the games. Participants will be asked to rate the accessibility of gameplay mechanics, clarity of instructions, and the colour schemes used in game pieces and so on. The findings revealed significant insights into how different demographic groups perceive and experience these elements, highlighting specific areas where improvements are needed to ensure that the games are enjoyable and accessible to a broader audience.

   The survey will also be designed to capture the nuanced views of the participants. Open-ended questions will allow respondents to express their thoughts and feelings in their own words, providing rich, detailed data. These questions will focus on the participants experiences with board games at exhibitions, any challenges they faced due to temporary disabilities, and their suggestions for improvements.

2. Semi-Structured Interviews Following the survey: semi-structured interviews will be conducted to delve deeper into the topics raised by the participants. These interviews will provide an opportunity for a more dynamic and detailed exploration of the visitors experiences and desires. The flexible nature of semi-structured interviews will enable us to probe further into specific areas of interest that emerge from the survey responses.

4.2.1 Mixed Methods Research - Quantitative and Qualitative Data

Mixed methods research combines qualitative and quantitative approaches, providing a richer, more comprehensive understanding of research problems than either method alone. This methodology is especially useful in complex fields like game accessibility, where both numerical data and detailed narratives are crucial to comprehensively addressing the multifaceted challenges and solutions.

This mixed methods study is used because the desire is to capture a broad range of

data, from statistical trends to personal experiences and perceptions, in the study of accessibility to board games at game exhibitions. **Quantitative data** will allow for the assessment of the prevalence and types of accessibility issues encountered, offering a measurable and scalable analysis that can inform broader interventions. This data will help us select the three games we wish to focus on and further develop. Additionally, the data will be valuable in identifying the types of accessibility issues present in the games. It will also assist us in recognising the main demographics of the exhibition, thereby clarifying our focus group and enabling us to design solutions that are specifically made to these individuals. However, the quantitative approach alone might miss nuanced aspects of the user experience that are vital for developing effective and user-centred accessibility solutions.

Qualitative data, on the other hand, can help us to gain a comprehensive understanding of the visitors perspectives on board game accessibility. It provides depth and context to these issues by capturing detailed accounts of the challenges faced by individuals with various accessibility needs. It offers insights into the emotional and subjective aspects of accessibility, such as player satisfaction and the social inclusivity of the game environment. These insights are crucial for understanding the why behind the data, such as why certain accessibility features succeed or fail [44].

4.2.2 Questionnaires

A questionnaire is a research tool consisting of a series of questions or prompts designed to gather information from respondents about their attitudes, experiences, or opinions. Questions such as multiple-choice or Likert scale items are effective for collecting quantitative data, while open-ended questions can elicit more qualitative and detailed information. This makes the questionnaire a versatile method for gathering both quantitative and qualitative data efficiently. Researchers choose questionnaires to seek feedback on user experiences. Creating a valid and reliable questionnaire involves designing standardised questions that address research objectives. Proper consideration of question wording and order is needed to collect data that can be generalised to a larger population. [45]

4.2.3 Semi-structured Interviews

A semi-structured interview is a data collection method that combines elements of both structured and unstructured interviews. Unlike fully structured interviews with predetermined questions in a fixed order, and unstructured interviews with no set questions, semi-structured interviews strike a balance. In these interviews, the interviewer has a thematic framework but retains flexibility in phrasing and question order. Here are some key points about semi-structured interviews:

Semi-structured interviews are often qualitative and exploratory in nature. While some questions are predetermined, others emerge spontaneously during the conversation. This flexibility allows for deeper exploration and understanding. Semi-structured interviews also provide comparable data across respondents, making them valuable for analysing patterns and trends. In short, semi-structured interviews of-

fer the reliability of structured interviews and the adaptability of unstructured ones. Allowing us explore deeply while maintaining a systematic approach. [46]

4.2.4 Advantages of Mixed Methods Research

The primary advantage of using mixed methods in this research is its ability to provide a comprehensive analysis that utilises the strengths of both quantitative and qualitative research. This approach enables: [47]

- **Triangulation:** By comparing qualitative and quantitative data, we can cross-validate findings and enhance the reliability of the results.
- **Complementarity:** Qualitative insights can explain the patterns observed in quantitative data, and vice versa, providing a fuller picture of the research problem.
- **Complete Utilisation:** Mixed methods allow for the complete utilisation of data collected from different sources and through various methods, maximising the information that can be gleaned from the research.

4.2.5 Summary

A mixed methods design is well-suited for the study of board game accessibility at game exhibitions because it offers a very solid framework in consideration of the complexity of this topic. This design will capture not only the statistical prevalence of the issue but also the experiences of participants, shaping solutions that are data-driven and deeply informed by user needs. Therefore, it is an ideal approach for such a study, as it would go further in bridging empirical data with real-world applicability, hence leading to better, more inclusive, and practical solutions in designing accessible game experiences.

4.3 Prototyping and Testing

A prototype is a sample of a product usually constructed in the early stages of development.

There are many reasons to create a prototype. For example, the developing team may want to test the product's main features and see if they meet the desired requirements. Prototyping can help in a broader testing scenario where testers can identify errors or areas that could be improved, not just regarding the main features, but the entire product [48].

Prototyping allows the developing team to create inexpensive models before continuing with a, probably, more costly final product. There can be multiple prototypes during the development phase, with each one building on the feedback from the previous one. Sometimes multiple prototypes are constructed at the same time, tested and compared between them so that the developers can identify which one of them would be better.

In other cases, prototypes can be used so that the developing team expresses their ideas and the logic behind them. This means they can present many different alternatives, which do not necessarily meet the needed requirements but showcase their thinking. This facilitates a more open approach to design, which includes many different possibilities [49].

One kind of prototyping is low-fidelity prototypes. This means that they are basic versions of the product without many details and the goals is to test its main features. Usually, various visual elements and not must-have features are missing.

Stakeholders such as users, customers, developers or other directly or indirectly involved partners may participate in testing sessions during which they can provide feedback. Testing sessions can be conducting in many forms, using questionnaires, or structured, semi-structured or open interviews with participants.

4.4 Ethical Considerations

In conducting research, it is crucial to adhere to ethical standards to respect the rights and well-being of all participants. Here are the key ethical considerations within our study:

1. Informed Consent When involving young children: When interviewing children who are 16 years old or younger, we will obtain consent from their parents or legal guardians. This ensures that those responsible for the child are fully informed about the research and agree to their childs involvement.

2. Permission for Recording: Before recording any interviews or interactions, we will seek explicit consent from the participants. This step is crucial to respect their privacy and autonomy.

3. Respect for Participant: While observing participants at the exhibition, we will maintain a respectful distance to avoid making anyone feel uncomfortable or observed too closely.

4. Maintaining Confidentiality: We will treat all information collected with strict confidentiality. Participants data will be anonymised in any reports or publications resulting from this research.

5. Voluntary Participation: All participants will be informed that their involvement is voluntary and that they can withdraw from the study at any time without any repercussions.

6. Debriefing After participation, individuals should be provided with a debriefing session to explain the studys findings and the role their contributions played.

We will follow these ethical guidelines during our research to respect the rights and well-being of our participants. Key considerations include obtaining informed consent from parents or guardians for young children, asking for permission before recording, being discreet with the type of data collected, informing participants that

their participation is voluntary and they can withdraw at any time, and providing debriefing sessions to explain the study findings and their contributions both during and after the research.

5

Execution

This chapter will present preliminary findings of our study, detailing the steps taken - from designing and distributing surveys to conducting interviews as well as the information gathered during this process. This discussion will connect the collected data to the analysis of the selected games.

5.1 Accessibility Challenges in the Tabletop games

this section will be more focused on the accessibility issues of the games. It begins with an accessibility evaluation for each game that was included in the study following the structure of Accessibility Tear-down by Meeple Like Us, and Universal Design by Ronald Mace.

5.1.1 Chaturaji

One of the primary challenges in Chaturaji is the design of the game pieces, which feature carved small numbers on their sides to indicate point values. This makes it difficult for players to easily discern how many points each piece is worth at a glance. The lack of clear, visible markings on the top or bigger numbers on the front of the pieces could hinder gameplay, especially for those who may have difficulty recognizing or remembering the point values associated with different symbols. Additionally, some numbers are printed reversely as shown in Figure 5.1, which may cause confusion for players and further emphasizes the need for consistent and correct printing.

Figure 5.1: Reversely printed number on Chaturaji pieces

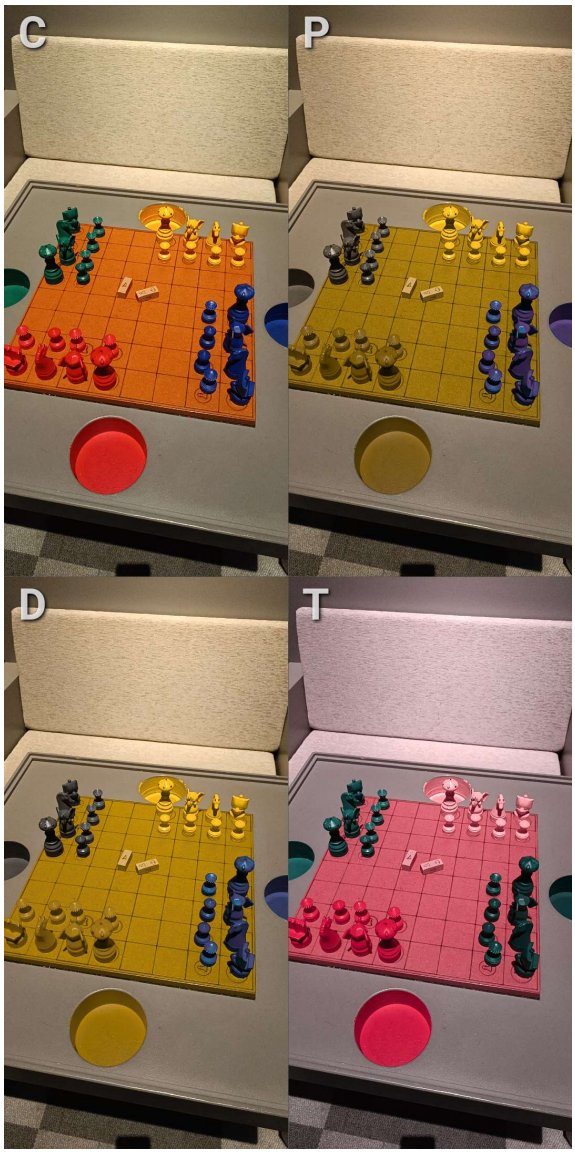

Figure 5.2: View of Chaturaji through CVS

The game pieces in Chaturaji are colour-coded in blue, green, red, and yellow. While this colour scheme is vibrant and distinct for most players, it presents challenges for those with colour vision deficiencies. Using a Chromatic Vision Simulator (CVS), it has been observed that players with protanopia and deuteranopia can differentiate between the colours. However, players with tritanopia may struggle to distinguish between the green and blue pieces as shown in Figure 5.2 T, potentially leading to confusion and a less inclusive gaming experience.

5.1.2 Mekuri

Challenges have been identified in the course of evaluating the accessibility of Mekuri for its potential user experience in a museum environment. One significant issue is the use of different colours to represent the suits of the cards instead of distinct symbols or patterns. Notably, the deep blue colour used for one of the suits is

very similar to black, especially when viewed under low-light conditions. Given that the museum environment tends to be dimly lit, this colour similarity could lead to temporary visual impairment, making it difficult for players to distinguish between the suits. This could potentially reduce the overall enjoyment and accessibility of the game for individuals with visual impairments or those affected by poor lighting.

Additionally, the method for calculating the final score in the game is cumbersome and not user-friendly. The complexity of the scoring system may compel players to use a calculator to determine their final score, which is both inconvenient and detracts from the immersive experience of the game. These issues highlight the need for design improvements to enhance the accessibility and user-friendliness of Mekuri, particularly in settings with challenging lighting conditions.

5.1.3 Huuchuish

The game pieces in Huuchuish are crafted from walnuts, which could present health risks for individuals with walnut allergies. Handling these pieces may trigger allergic reactions, ranging from mild skin irritation to more severe symptoms. This could make it difficult or even unsafe for those with nut allergies to participate in the game, limiting their ability to enjoy the experience.

Figure 5.3: Playable version of Huuchuish at the museum

A key element of Huuchuish involves picking up, holding, and throwing walnuts, which are central to the gameplay. This physical aspect of the game may pose significant challenges for players with motor disabilities, whether permanent or temporary. Individuals with limited hand dexterity, strength, or coordination might find it difficult to participate fully, creating barriers to engagement and enjoyment.

5.1.4 Ganjifa

Ganjifa has vibrant use of colour to distinguish between different suits. While these colour-coded suits are integral to the aesthetic and functional aspects of the games, they present significant accessibility challenges, particularly for individuals with visual impairments. Both Ganjifa and Mekuri rely heavily on colour to differentiate

between suits, making it difficult for individuals with colour blindness or other visual impairments to distinguish between the cards. This reliance on colour poses a significant barrier to inclusivity, as players who cannot perceive these colours may struggle to engage fully with the game. The rich history and cultural significance of these games are further obscured for these individuals, especially when these cards are displayed in a museum setting without alternative means of identification.

Figure 5.4: Playable version of Ganjifa at the museum

For people with visual impairments, including colour blindness, the colour-coded suits of Ganjifa can be a major obstacle. Museums or game exhibitions that display these cards without considering accessibility modifications may inadvertently exclude a portion of their audience. These individuals might not be able to appreciate the intricate details or the colour-based categorisation of the cards, which are central to the game's rules and playability.

5.1.5 Weiqi/Go

Weiqi is arguably the most well-known game in the exhibition and continues to enjoy widespread popularity today. Its lasting appeal is due to its comprehensive rules and the vast possibilities it offers in gameplay. Despite its complexity, Weiqi does not present significant accessibility challenges beyond its learning curve, which can be overcome with proper instruction and practice. The games structured nature and established rules make it accessible to a broad audience, provided that suitable educational resources are available.

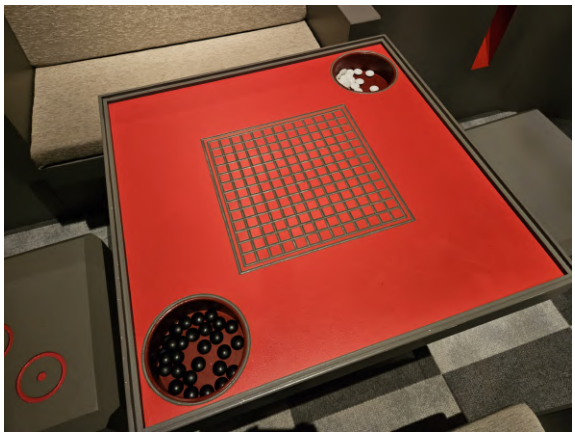

Figure 5.5: Playable version of Weiqi at the museum

While the museum offers an introduction to Weiqi through Atari-Go, it falls short of teaching the complete game. Atari-Go is a simplified version, focusing on the fundamental mechanics but lacking the depth and complexity of the full Weiqi experience. This approach may limit visitors' understanding of the rich strategic layers that make Weiqi so revered, especially for those interested in delving deeper into the traditional game.

A positive aspect of the museum's Weiqi exhibit is the inclusion of a game board that is engraved into the table surface. This design choice provides tactile feedback, making the game more accessible to visitors with visual impairments. The engraved lines and intersections allow players to feel the board's layout, enabling them to participate in the game through touch, which is a crucial consideration for inclusivity.

5.1.6 Shagai

Shagai involves picking up, holding, and throwing up to 30 shagai pieces, which can pose significant challenges for players with motor disabilities. The physical demands of handling such a large number of pieces may be difficult for individuals with limited hand dexterity, strength, or coordination. Additionally, players with smaller hands, including children, may struggle to manage the pieces effectively, potentially impacting their ability to participate fully in the game.

Figure 5.6: Playable version of Shagai at the museum

The game also requires players to flick the shagai with their fingers, an action that can create unnecessary barriers. For some individuals, this flicking motion may be difficult or impossible to perform due to physical limitations, discomfort, or other reasons. This requirement can exclude or disadvantage players who cannot comfortably engage in this specific motion, limiting their ability to enjoy the game.

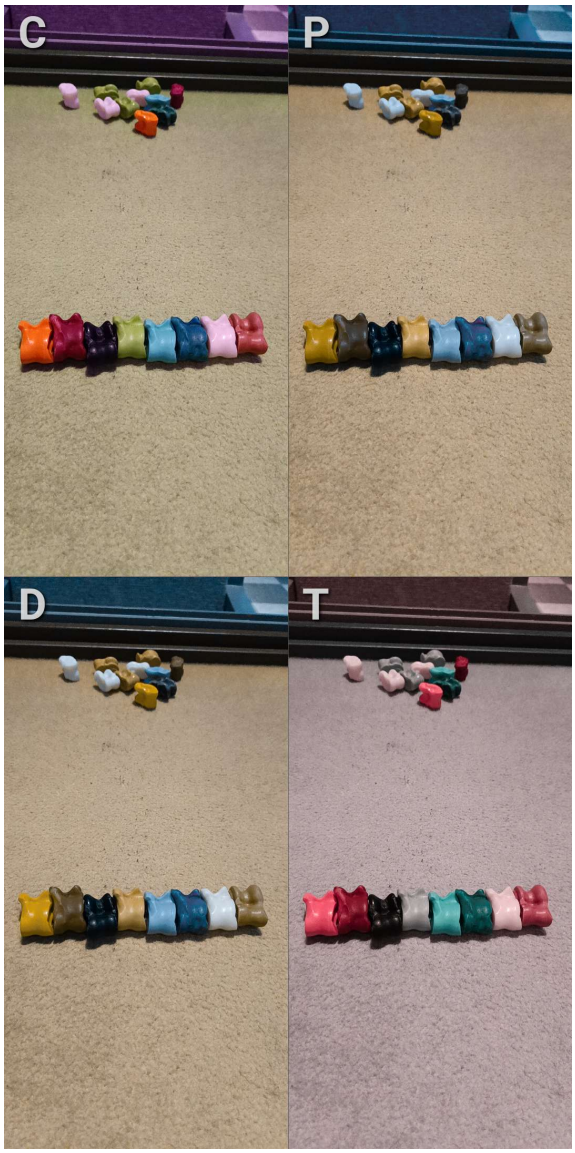

Figure 5.7: View of Shagai through CVD

While the shagai pieces are coloured, testing with a Colour Vision Simulator(CVS) indicates that distinguishing between the colours is challenging for individuals with monochromacy or any type of dichromacy (protanopia, deuteranopia, or tritanopia). However, since the colour of the shagai does not impact gameplay, this does not constitute a significant accessibility challenge. The focus remains on the physical interaction with the pieces, where the primary barriers are related to motor skills and hand size rather than colour perception.

5.1.7 Senet

While Senet does not present any obvious physical accessibility challenges, the game's historical context introduces a different kind of barrier. Since Senet is an ancient game with rules that have not been fully preserved over time, some of the grid

patterns on the board have lost their original meaning. The museum has opted to allow players to interpret these patterns and decide how to proceed during gameplay.

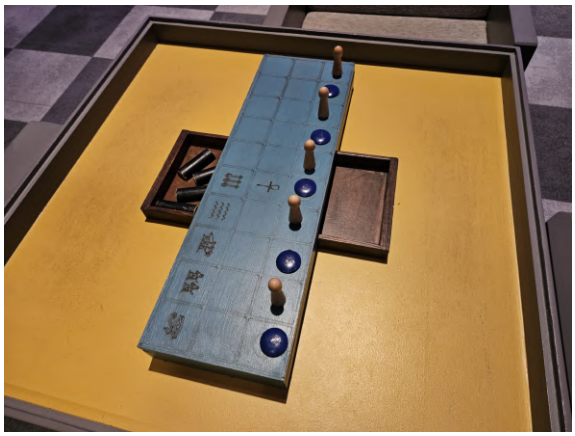

Figure 5.8: Playable version of Senet at the museum

However, this open-ended approach may present challenges for players who prefer clear guidance or those who are less familiar with the game. Without defined rules, players might spend more time trying to interpret the patterns and decide on their actions, which could detract from the overall experience. Additionally, if players choose not to engage with the patterns meaningfully, the game might become monotonous and less engaging.

To enhance the accessibility and enjoyment of Senet, the museum could consider developing a set of standardised rules that incorporate the existing patterns on the board. This would provide players with a more structured experience, allowing them to engage with the game more quickly and with greater confidence. A clear rule set would also ensure that the gameplay remains dynamic and interesting, even for those who are unfamiliar with the ancient context of Senet.

5.2 Questionnaires

As mentioned above, we wanted to collect quantitative data on user demographics, user preferences, and accessibility ratings on various aspects of the games. In order to gain this information we created a questionnaire.

We had a discussion with the museum staff and decided that it will be better if we made the questionnaire available in both English and Swedish. The goal was to have as many visitors of the exhibition to answer the questionnaire. We believed that offering the questionnaire in both English and Swedish would help us reach a broader audience, including those who may not be fluent in either language or who may feel more comfortable participating in a survey presented in their preferred language. Additionally, we aimed to gather responses from people of all ages, including younger children and older individuals, who often may not be fluent in both languages. Our thesis aims to make the board games and the exhibition more accessible, so it was important to us that the questionnaire would be as accessible as possible.

During our discussion, we also both agreed that it would be better if we created a poster and placed it at the exhibition, so that more people would know about the survey taking place and would be attracted to participating. One point of debate was that we did not want the visitors to know beforehand about it, so that their playing experience would remain unaffected. For this reason, we decided to place the poster at the exit of the exhibition. The plan was for visitors to see it when they were on their way out, after having played the board games.

We created numerous drafts for the poster, starting from a simple, minimalist black-and-white one. However, together with the museum staff, we decided that the poster should utilise vibrant colours and engaging images to draw attention and fit in with the rest of the exhibition. We removed the 'Confidentiality Assurance' part from the poster and only kept a shorter version of the text, to make it more appealing. Similarly to the questionnaire, we created two versions of the poster, one in Swedish and one in English. QR codes were added to each version, allowing visitors to quickly and easily access the questionnaire.

We decided that a number of 30 responses on the survey would be adequate for our research, and that we could reach this number in 8 days (from 06/04/2024 to 14/04/2024, excluding Monday 08/04/2024 because the museum is closed on Mondays).
In the end, we managed to get 36 responses in total, exceeding the goal we had set. 30 of those were in the Swedish version, and 6 in the English one.
As we realised, most people visit the exhibition on weekends, and we got the vast majority of our responses these days. Looking back, if we wanted to increase our efficiency, we could have focused mostly on weekends, probably reaching the same number in fewer days, or if we still dedicated 8 days, reaching an even higher number.
We also decided that it would be better if all questions that asked participants to rate an aspect of a game on a scale from 1 to 5 would be similarly posed. For example, if it is a question on the level of difficulty, we ask 'how easy...' and then 1 means it was 'very difficult', while 5 means it was 'very easy'.

5.2.1 Introductory Questions

The first page of questions consists of demographic questions and ones who aim to help us understand the participants' background and preferences regarding the exhibition.
The first question is 'What is your age?' A reason we ask this is because we wanted to have a broad range of responses, including younger children. 5 out of 36 of the respondents (13.9%) replied that they are between 0 and 12. Only 3 of them are between 13 and 20 years old; that is 8.3%. 14 out of 36, which is 38.9% replied that they are between 21 and 39 years old. Just as many are between 40 and 59, which is the remaining 38.9% of the questionnaire participants. We did not manage to find any participants older than 60 years old.

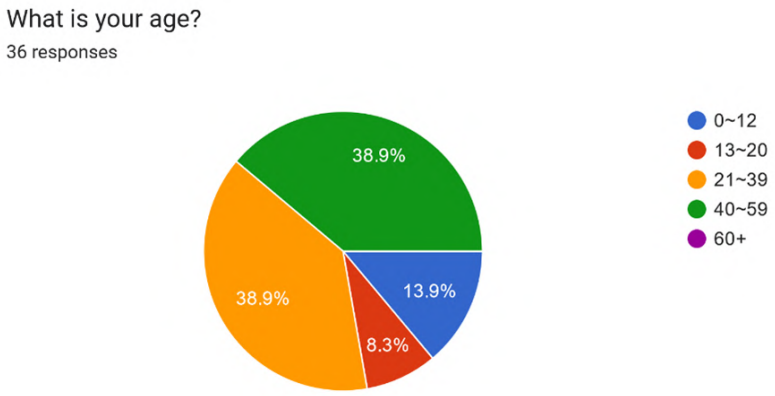

Figure 5.9: Age Distribution

The next question is 'How many times have you visited the 'A World of Games' exhibition?'. The reason we asked that is to see how much experience the respondents had with the exhibition and the seven board games. The vast majority of them, 29 out of 36 (80.6%), said this was their first visit, while 5 (13.9%) said it was their second. Only one respondent said that this was their third visit and another one said it was their fifth (2.8%).

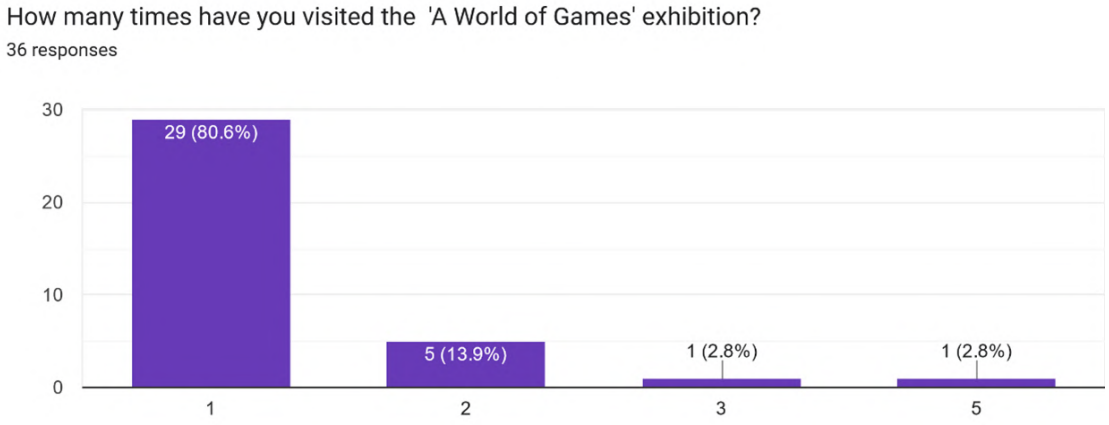

Figure 5.10: Frequency of Visiting the Exhibition

We also wanted to see how much they like or how experienced they are with tabletop games in general, so the third question on this page was 'How often do you play tabletop games?'. None of them said they never play tabletop games. 7 out of 36 (19.4%) replied 'Rarely - Once or twice a year', while 15 (41.7%) replied 'Occasionally - About once a month'. 9 (25%) said they play 'Regularly - A few times a month' and 5 (13.9%) play 'Frequently - Once a week or more'. Based on these

replies, we consider that our audience is fairly experienced with tabletop games and enjoys playing them in their free time.

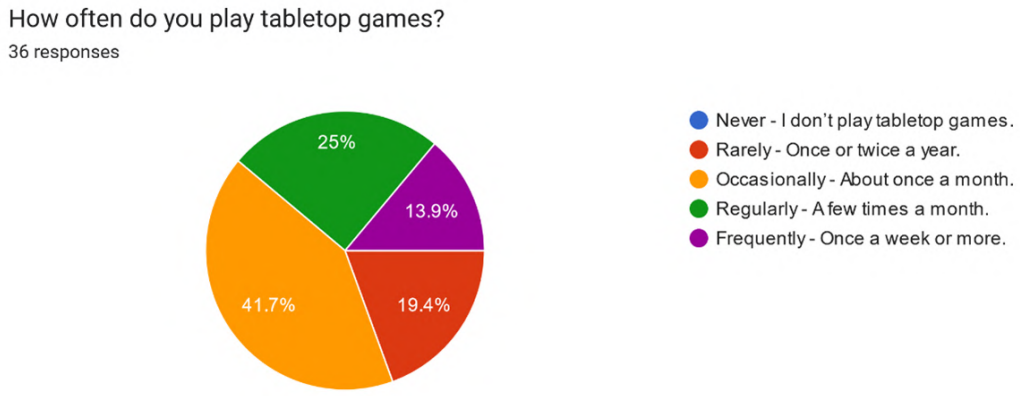

Figure 5.11: Frequency of Playing Board Games

As for the last question of the first page, we asked the participants which of the seven playable tabletop games in the exhibition they liked the most. We provided both the names and pictures of the games to help them remember which was which. Chaturaji was the most-liked game with 10 (27.8%) participants picking it as their favourite. Shagai was next with 8 votes (22.2%) and Weiqi came in third place with 6 (16.7&). Mekuri was fourth with 5 votes, followed by Huuchuish with 4, 13.9% and 11.1% respectively. Only one participant chose Ganjifa as their favourite game (2.8%).

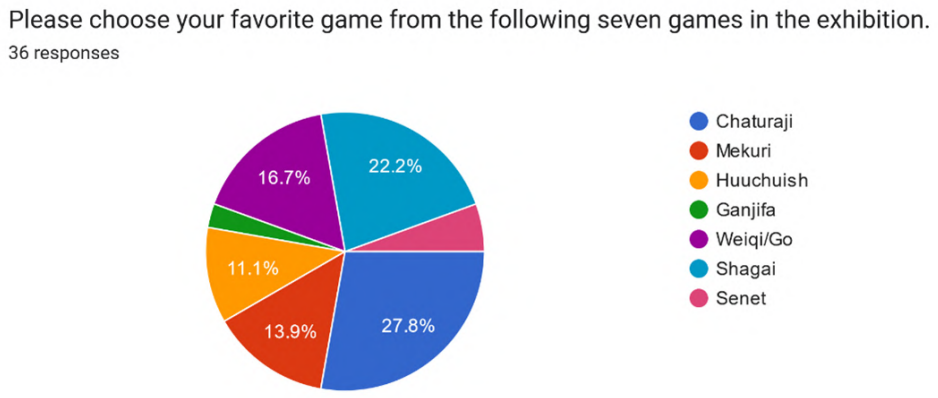

Figure 5.12: Favourite Board Game

5.2.2 Accessibility Questions

Subsequently, we posed questions about each of the seven games. While some questions were consistent across all games, certain games received additional, specific inquiries. During our talks with the museum staff, we agreed that the questionnaire, while detailed and able to provide the information we wanted to get, should not feel tiring or too long for the participants. This would also help us ensure a larger completion rate and increase the number of responses. For this reason, before continuing to the page with questions about a specific game, participants were asked to reply if they had played the game or not. If they replied 'Yes', they continued with answering questions about this game. If they replied 'No', the next questions page was automatically skipped and they continued with the same question ('Have you played [name of the game] at the exhibition?') for the next game. When talking with visitors at the exhibition, we made sure to explain that they had this option.

5.2.2.1 Chaturaji

Chaturaji was one of the most popular games, with 47.2% of participants having played it. It received a high average rating of 4/5 in terms of fun, reflecting its widespread appeal. Many players appreciated its similarity to chess, which made the gameplay feel familiar, while also enjoying the added twist of being able to play with two to four players. This flexibility likely contributed to its popularity, as it accommodated both smaller and larger groups. However, some participants raised concerns about the dice mechanic, which they felt restricted their ability to plan moves strategically. This aspect diminished the depth of gameplay for those who prefer strategic thinking over chance-based elements. Furthermore, there were suggestions to improve the clarity of the rules, particularly regarding the movements of special pieces like the horse and boat. Clearer instructions with visual aids could help address this issue, especially for players who are less experienced with similar games. Most participants completed the game within the ideal timeframe of 520 minutes, making it well-suited for the exhibition format. With minor adjustments to the mechanics and a focus on simplifying the instructions, Chaturaji has the potential to be even more engaging and accessible for a broader audience.

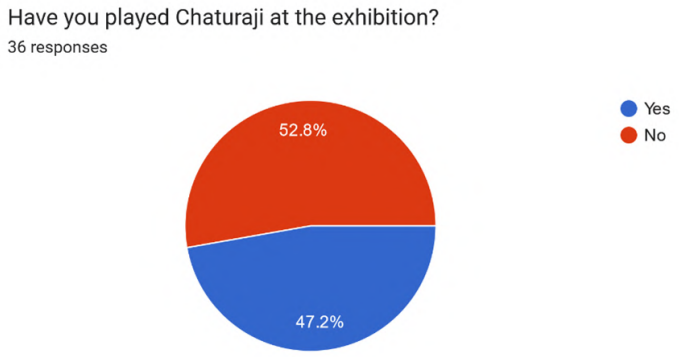

Figure 5.13: Have you played Chaturaji at the exhibition?

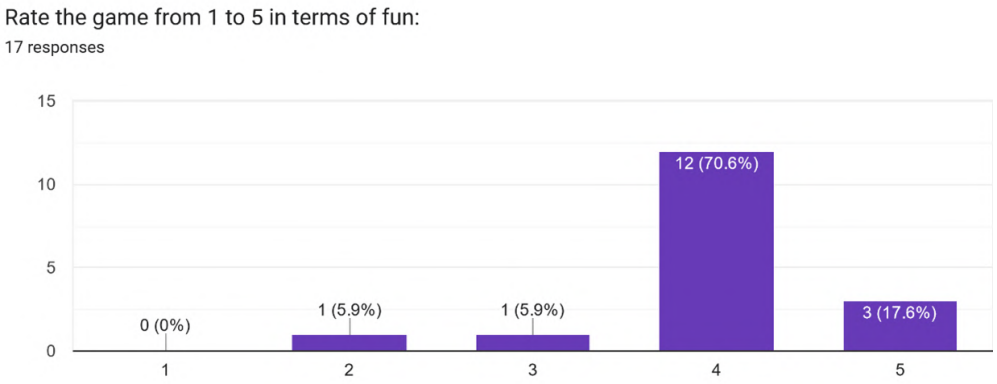

Figure 5.14: Rate the game from 1 to 5 in terms of fun.

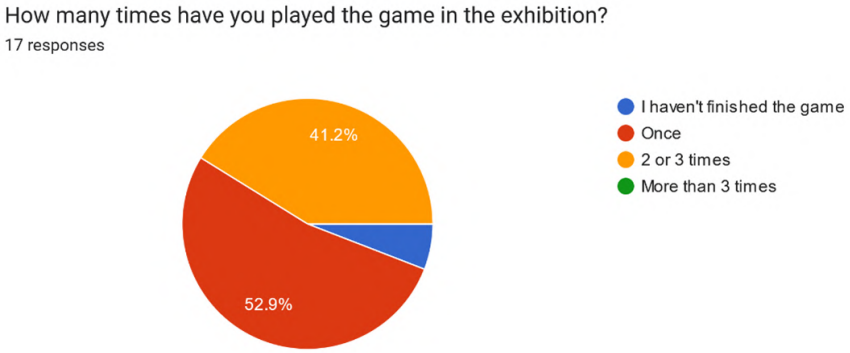

Figure 5.15: How many times have you played the game in the exhibition?

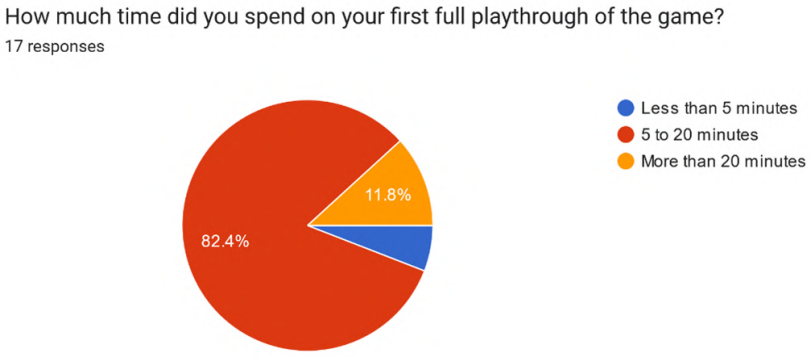

Figure 5.16: How much time did you spend on your first full playthrough of the game?

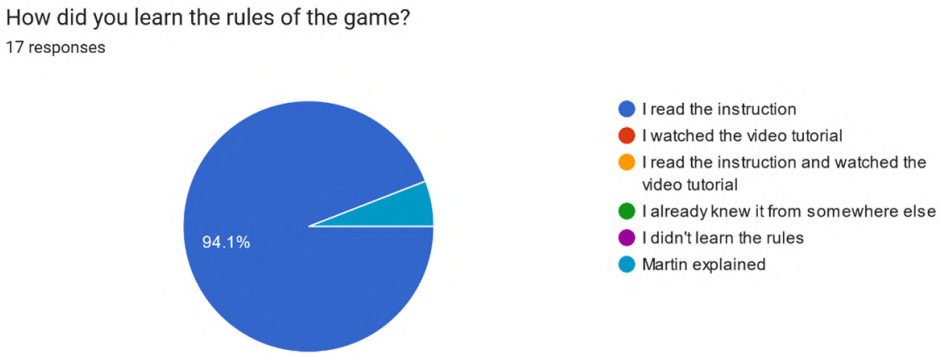

Figure 5.17: How did you learn the rules of the game?

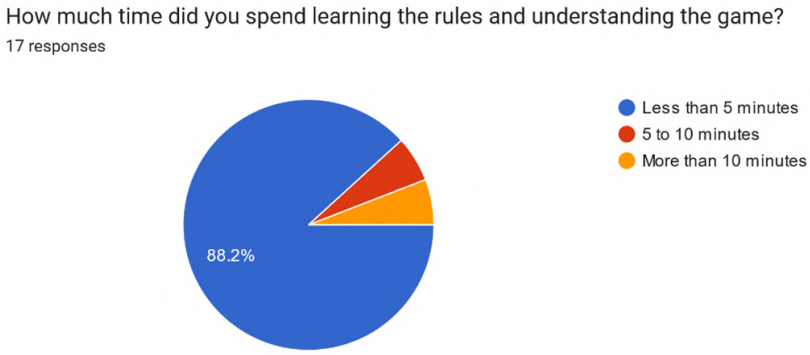

Figure 5.18: How much time did you spend learning the rules and understanding the game?

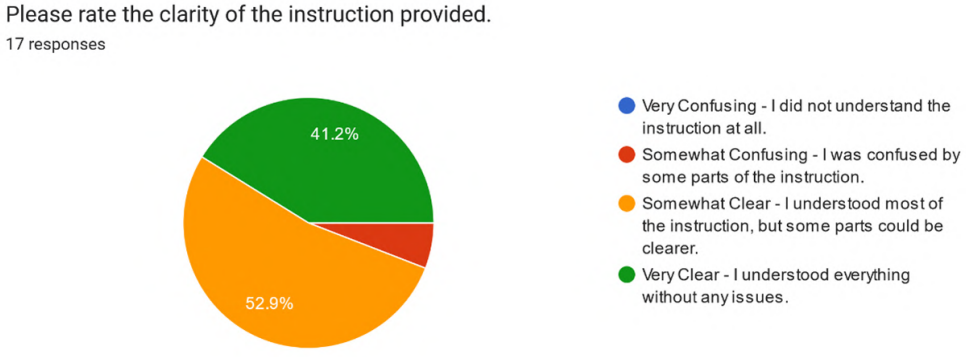

Figure 5.19: Please rate the clarity of the instruction provided.

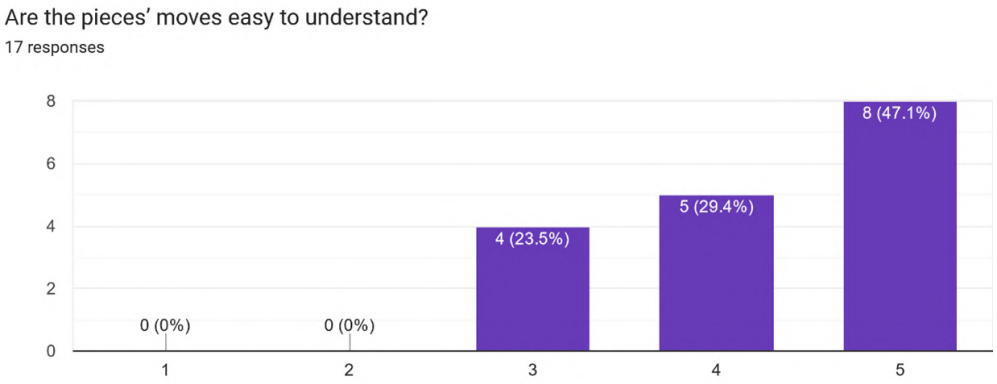

Figure 5.20: Are the pieces' moves easy to understand?

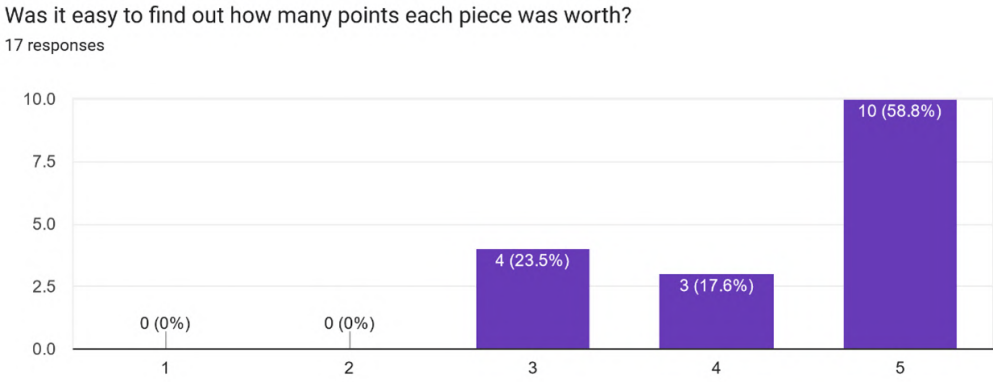

Figure 5.21: Was it easy to find out how many points each piece was worth?

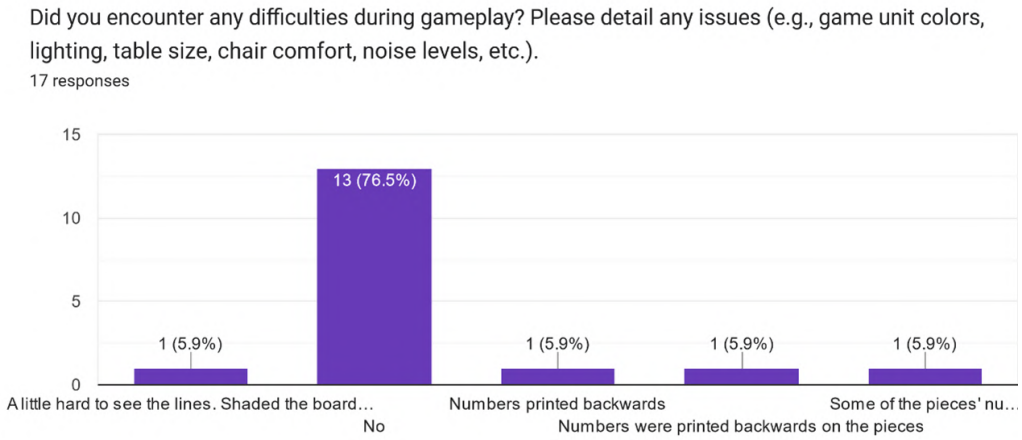

Figure 5.22: Did you encounter any difficulties during gameplay? Please detail any issues (e.g., game nit colours, lighting, table size, chair comfort, noise levels, etc.).

5.2.2.2 Mekuri

Mekuri was one of the less popular games in the exhibition, with only 11 out of 36 participants opting to play it. The game received an average fun rating of 3.36/5, which reflects moderate satisfaction among those who tried it. Despite its lower popularity, some visitors highlighted positive aspects, such as its unique scoring system and its portability, which makes it easy to play anywhere. However, the game faced several criticisms, particularly around its simplicity, which left little room for strategy. Participants noted that the rules were too basic, making it difficult to sustain interest for extended periods. Additionally, some players experienced challenges distinguishing between the dark blue and black cards, which affected gameplay and created unnecessary confusion. Handling and stacking the cards was another minor issue raised by players. Many participants completed the game in less than 5 minutes, which was considered too short to maintain engagement. Extending the duration of gameplay by adding more strategic elements or alternative rules could make Mekuri more appealing. Furthermore, clearer and more concise instructions, possibly supported by visual examples, could improve the initial learning experience and attract more participants.

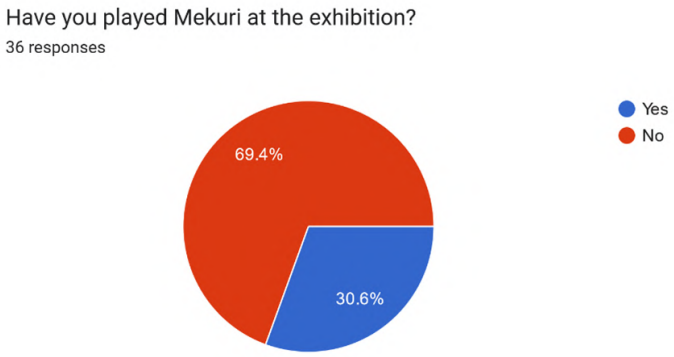

Figure 5.23: Have you played Mekuri at the exhibition?

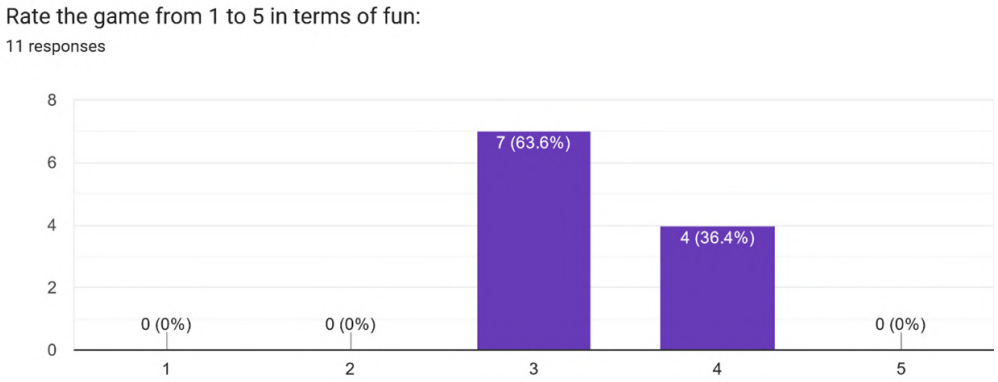

Figure 5.24: Rate the game from 1 to 5 in terms of fun.

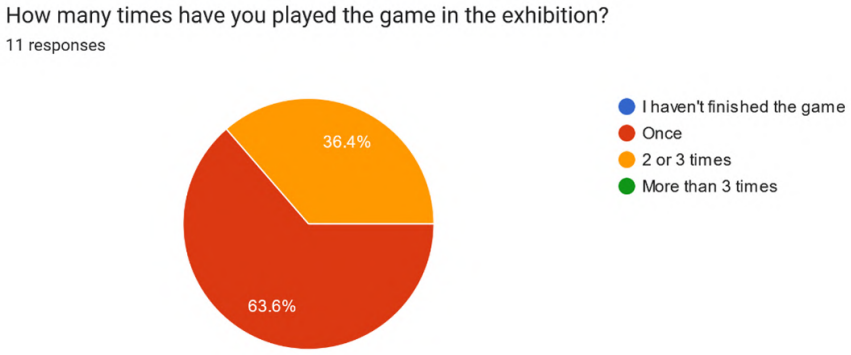

Figure 5.25: How many times have you played the game in the exhibition?

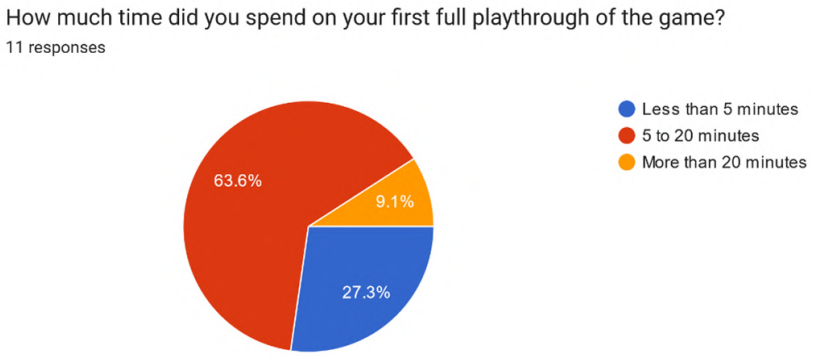

Figure 5.26: How much time did you spend on your first full playthrough of the game?

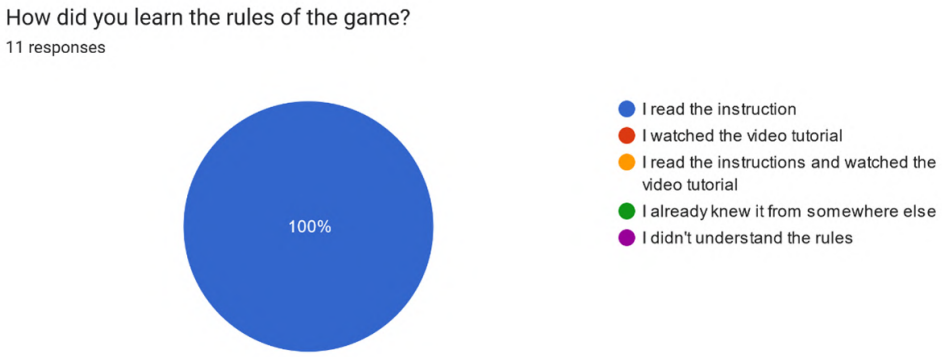

Figure 5.27: How did you learn the rules of the game?

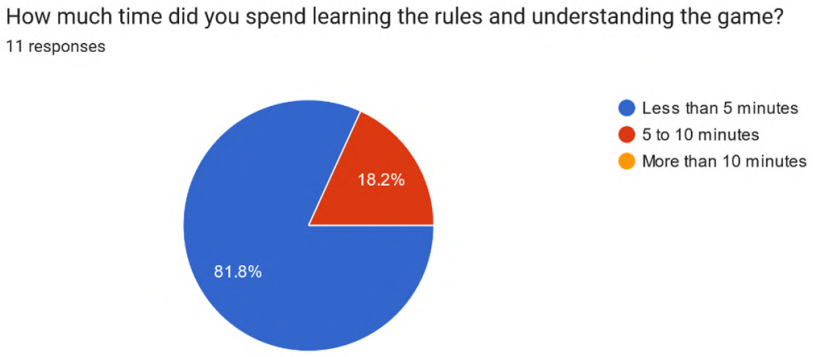

Figure 5.28: How much time did you spend learning the rules and understanding the game?

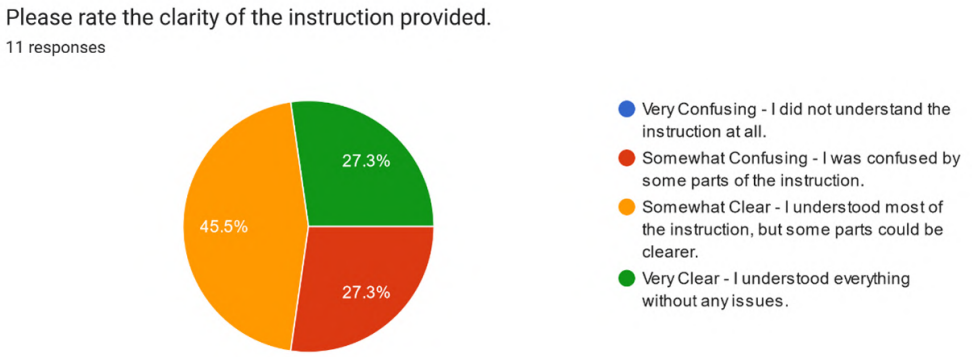

Figure 5.29: Please rate the clarity of the instruction provided.

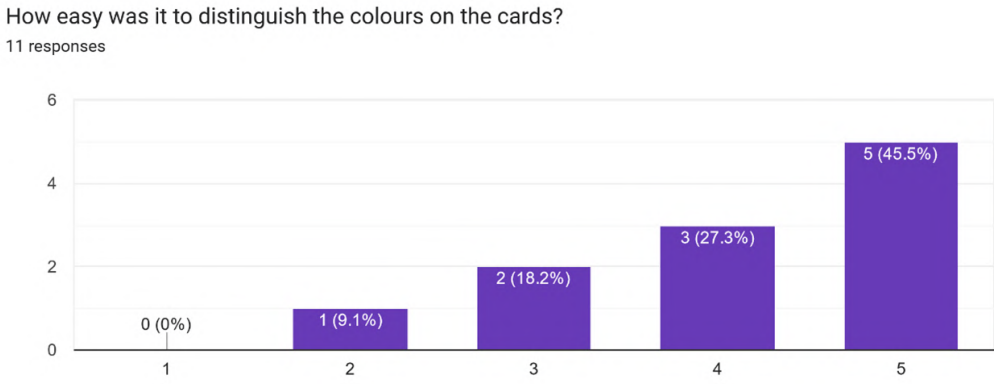

Figure 5.30: How easy was it to distinguish the colours on the cards?

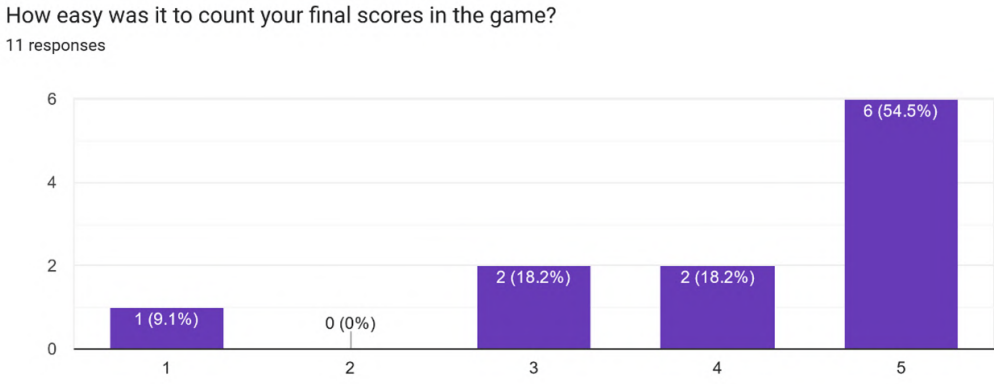

Figure 5.31: How easy was it to count your final scores in the game?

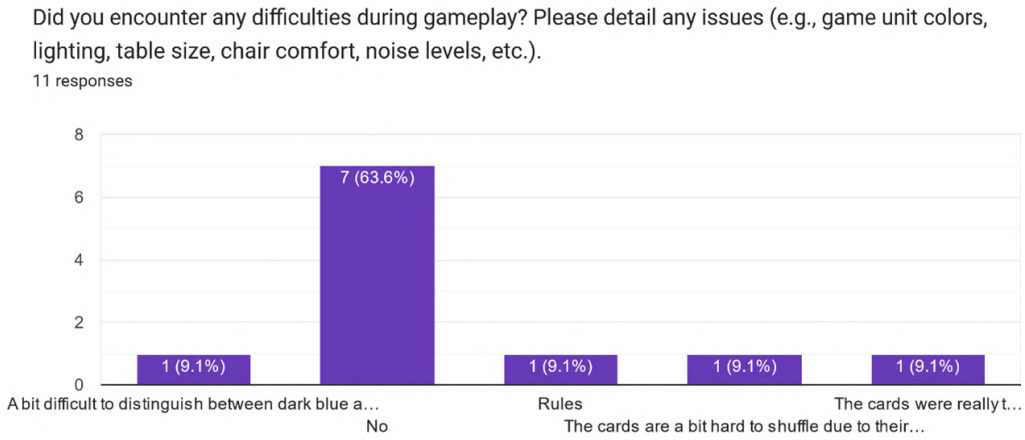

Figure 5.32: Did you encounter any difficulties during gameplay? Please detail any issues (e.g., game nit colours, lighting, table size, chair comfort, noise levels, etc.).

5.2.2.3 Huuchuish

Huuchuish was moderately popular, with 44.4% of participants playing it, but it received mixed feedback with an average fun rating of 3.06/5. While many appreciated the games simplicity and the ease of learning the rules, these same qualities were viewed as drawbacks by others. Several participants felt that the game was overly reliant on luck and lacked the depth needed to keep it interesting. The short playtime was another concern, with most players completing the game in under 5 minutes. Although its brevity may have appealed to those seeking quick, casual gameplay, it limited the games potential for deeper engagement. Suggestions for improvement included incorporating optional advanced rules to introduce more strategy and balance the reliance on luck. Some participants also noted gaps in understanding the use of certain game elements, such as sticks, and recommended providing additional context or examples to clarify their role. Enhancing the game mechanics and offering supplementary explanations could make Huuchuish more enjoyable while maintaining its accessibility.

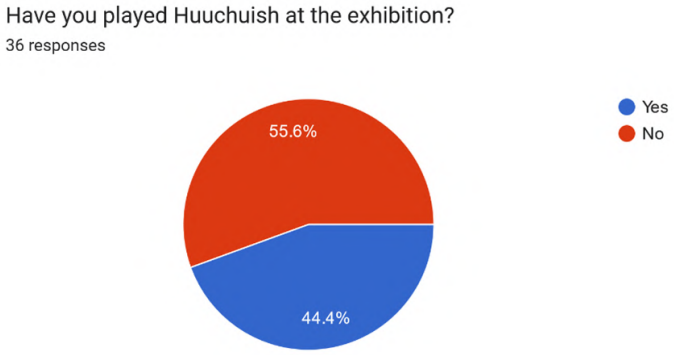

Figure 5.33: Have you played Huuchuish at the exhibition?

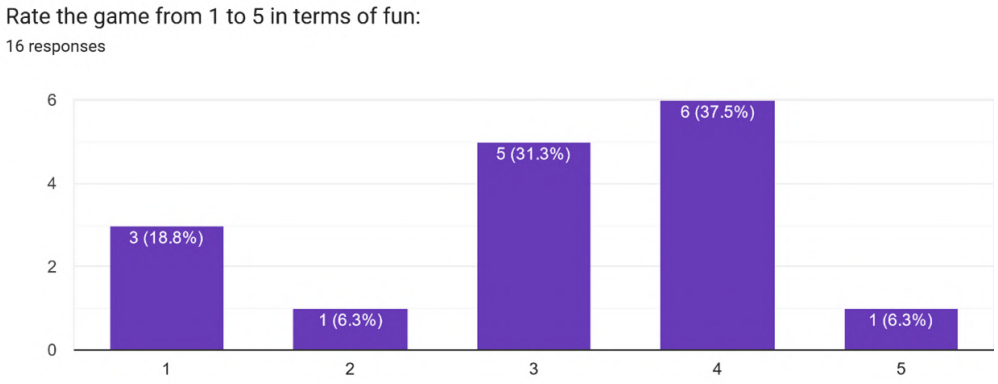

Figure 5.34: Rate the game from 1 to 5 in terms of fun.

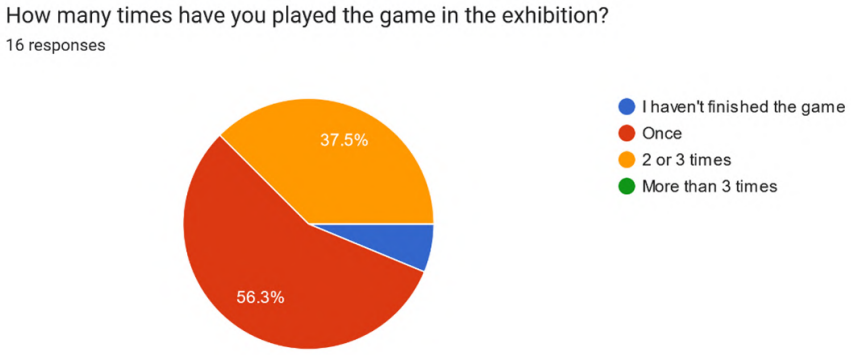

Figure 5.35: How many times have you played the game in the exhibition?

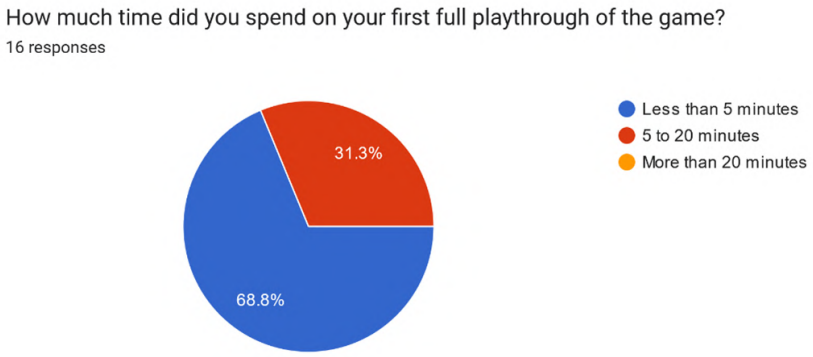

Figure 5.36: How much time did you spend on your first full playthrough of the game?

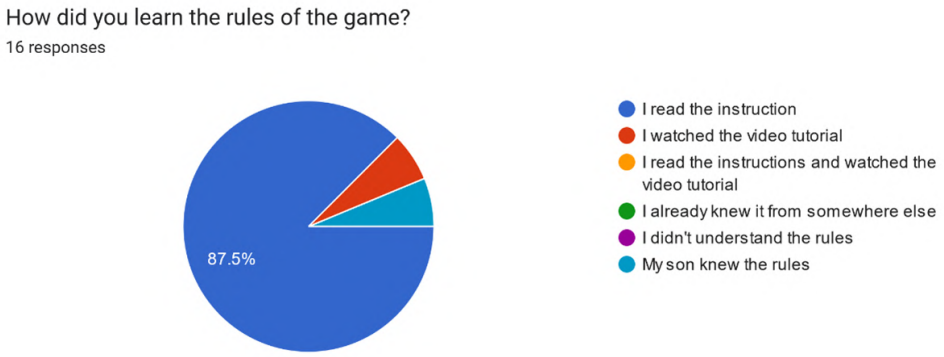

Figure 5.37: How did you learn the rules of the game?

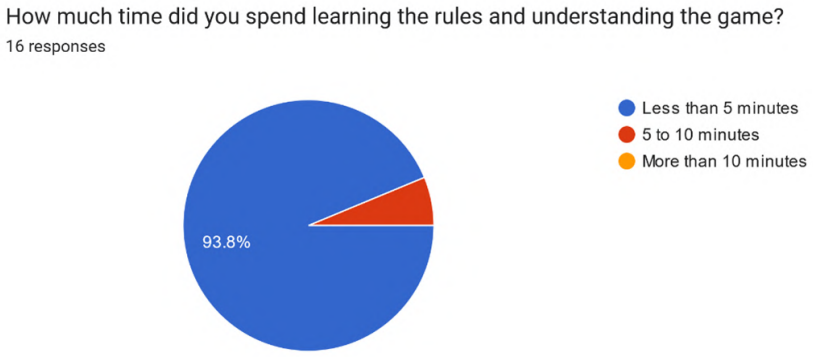

Figure 5.38: How much time did you spend learning the rules and understanding the game?

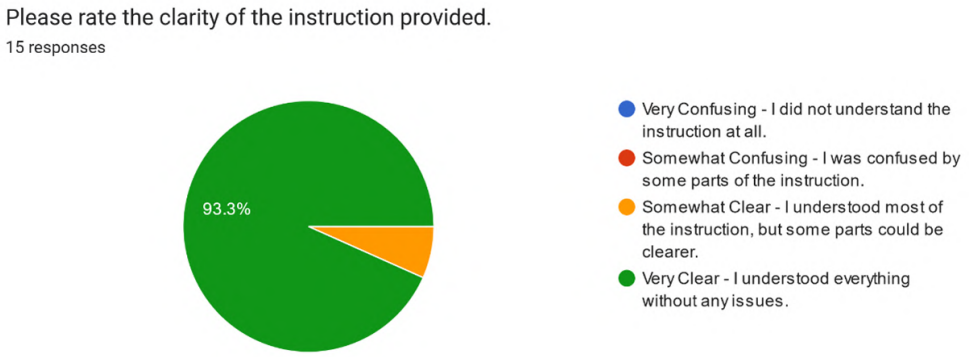

Figure 5.39: Please rate the clarity of the instruction provided.

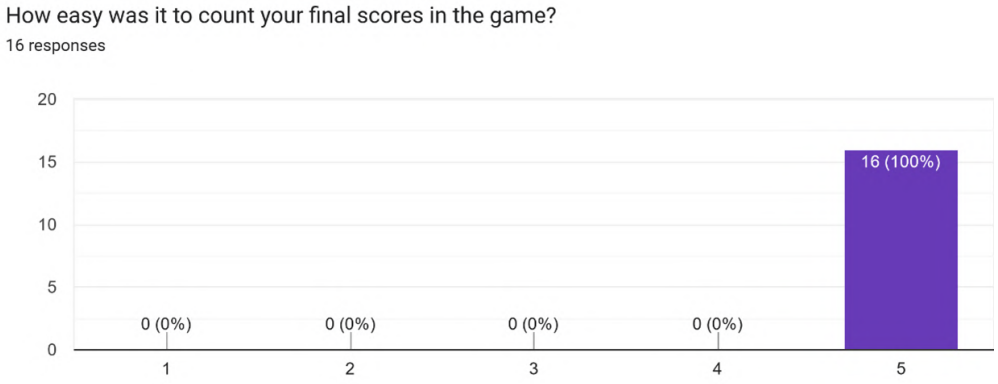

Figure 5.40: How easy was it to count your final scores in the game?

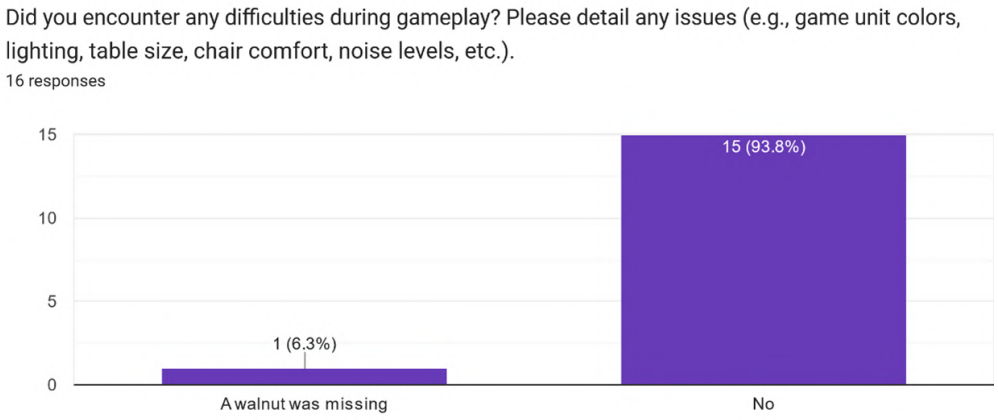

Figure 5.41: Did you encounter any difficulties during gameplay? Please detail any issues (e.g., game nit colours, lighting, table size, chair comfort, noise levels, etc.).

5.2.2.4 Ganjifa

Ganjifa was among the least played games, with only 10 participants engaging with it, and it received an average fun rating of 3/5. Despite its limited popularity, the game showed potential, particularly for multiplayer gameplay. Some participants noted that the game worked better with more than two players, which could make it more dynamic and engaging. However, the lack of strategic depth and limited appeal to first-time players may have contributed to its lower engagement levels. The rules, while clear for those who played, might benefit from a beginner-friendly introduction or an alternative gameplay mode that simplifies the learning process for newcomers. Most players completed their first playthrough within 520 minutes, which is consistent with the exhibitions goals, but additional promotional efforts might be needed to draw more attention to this culturally significant game. Highlighting its historical or artistic value could also increase its appeal and encourage visitors to explore it.

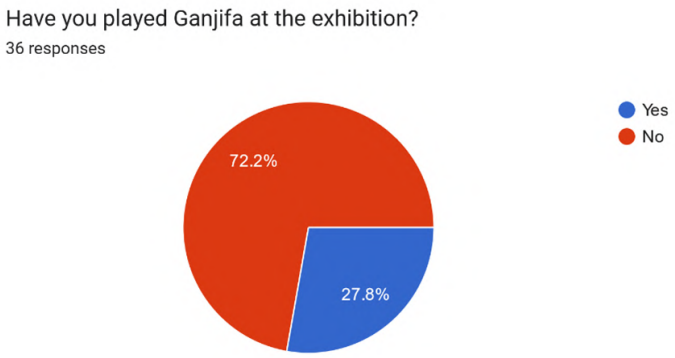

Figure 5.42: Have you played Ganjifa at the exhibition?

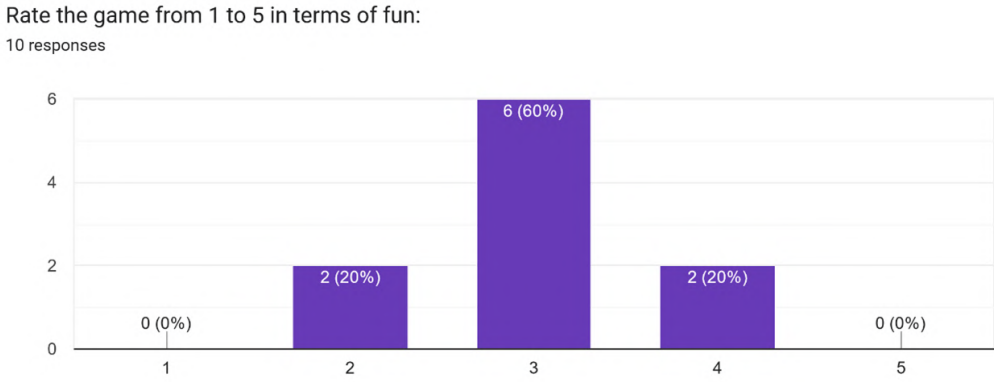

Figure 5.43: Rate the game from 1 to 5 in terms of fun.

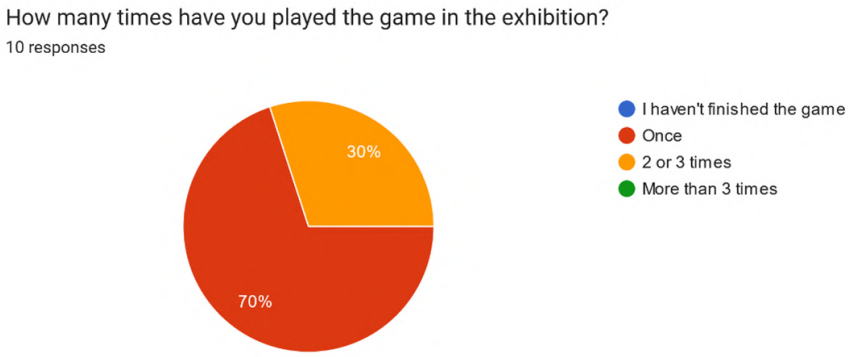

Figure 5.44: How many times have you played the game in the exhibition?

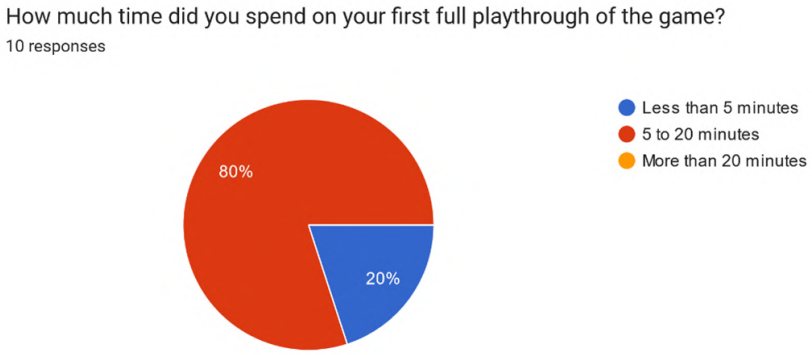

Figure 5.45: How much time did you spend on your first full playthrough of the game?

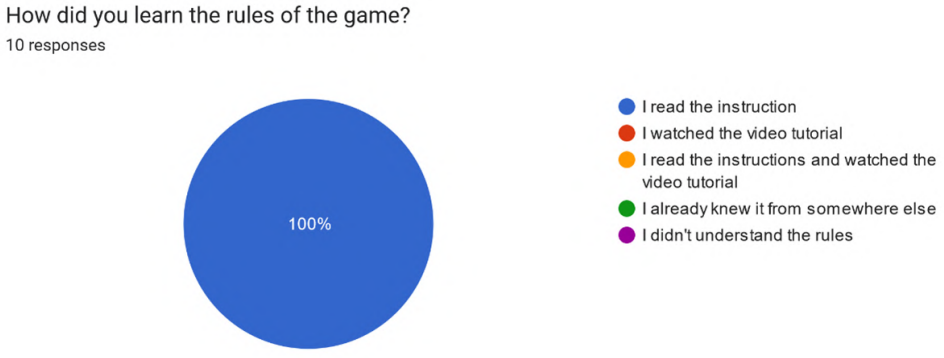

Figure 5.46: How did you learn the rules of the game?

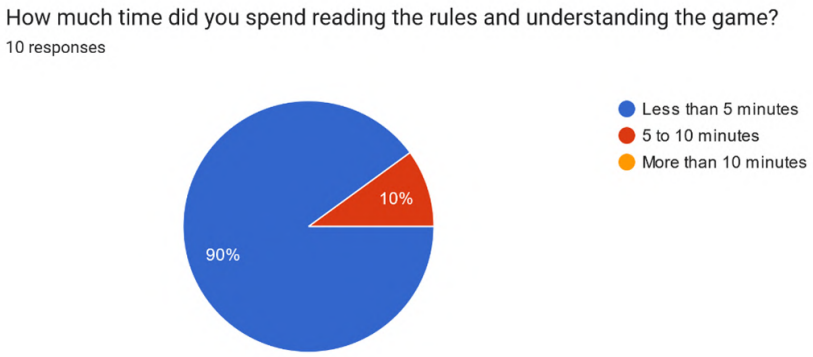

Figure 5.47: How much time did you spend learning the rules and understanding the game?

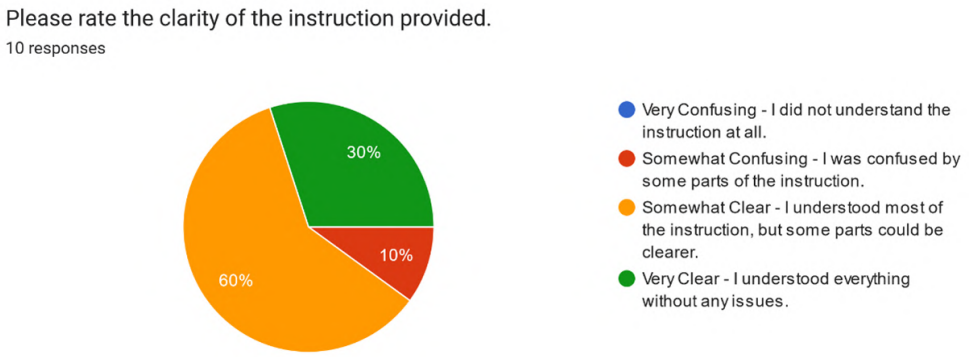

Figure 5.48: Please rate the clarity of the instruction provided.

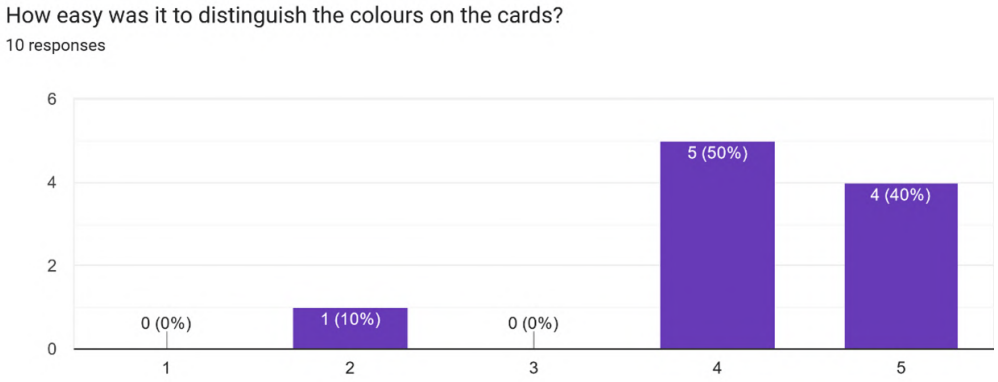

Figure 5.49: How easy was it to distinguish the colours on the cards?

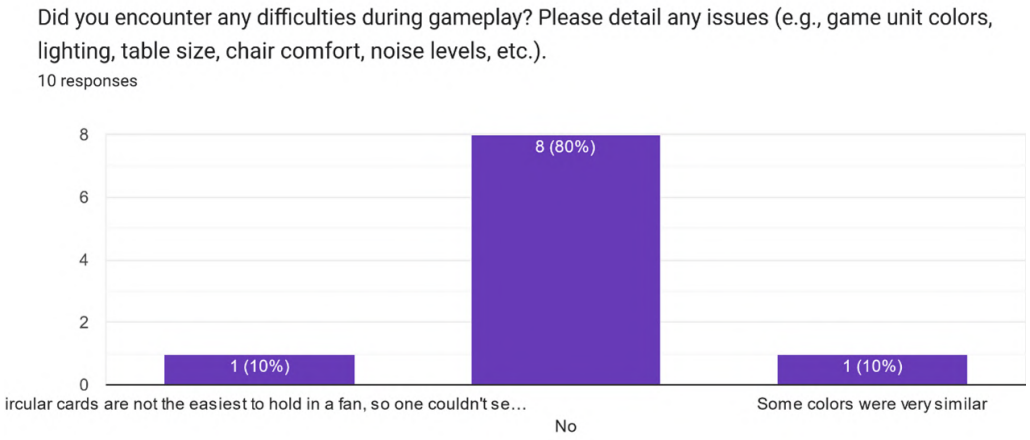

Figure 5.50: Did you encounter any difficulties during gameplay? Please detail any issues (e.g., game nit colours, lighting, table size, chair comfort, noise levels, etc.).

5.2.2.5 Weiqi (Go)

Weiqi was moderately popular, with 36.1% of participants playing it, and it received a relatively high average rating of 3.92/5. Visitors appreciated its strategic and logic-based gameplay, with some noting that the simplified version, Atari-Go, made it more accessible for inexperienced players. This accessibility likely contributed to its popularity, as it allowed participants to grasp the basics quickly while still offering the potential for deeper engagement. However, some players struggled with specific rules, such as understanding when opponent pieces were surrounded. Clearer visual examples or a demonstration of these mechanics could make the game easier to learn and more enjoyable. Most participants completed their playthrough within 520 minutes, making it a well-timed experience for the exhibition. For digital versions of the game, offering varying levels of difficulty could make it more inclusive, catering to both beginners and experienced players.

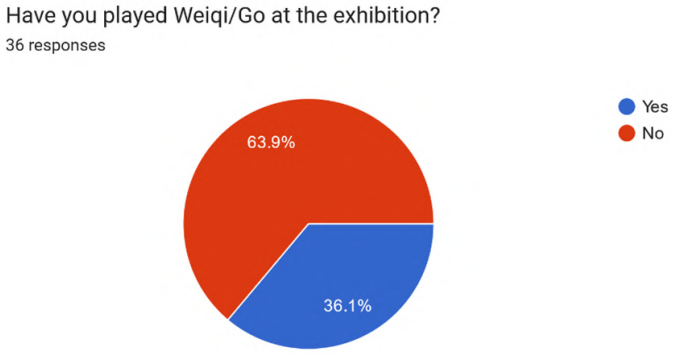

Figure 5.51: Have you played Weiqi/Go at the exhibition?

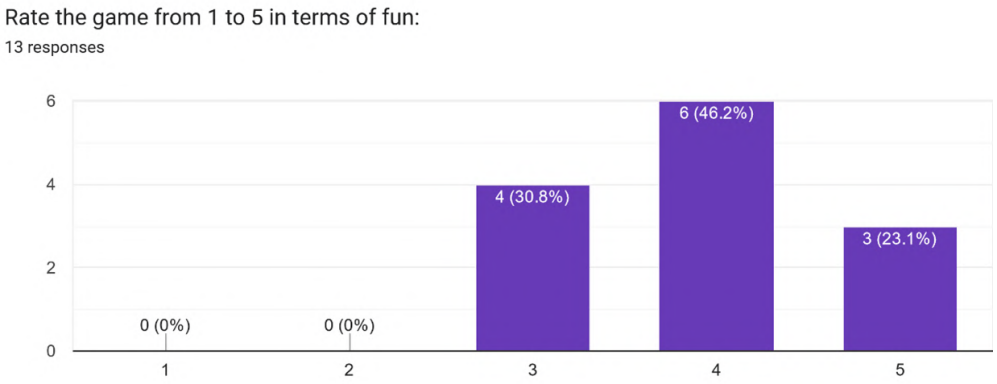

Figure 5.52: Rate the game from 1 to 5 in terms of fun.

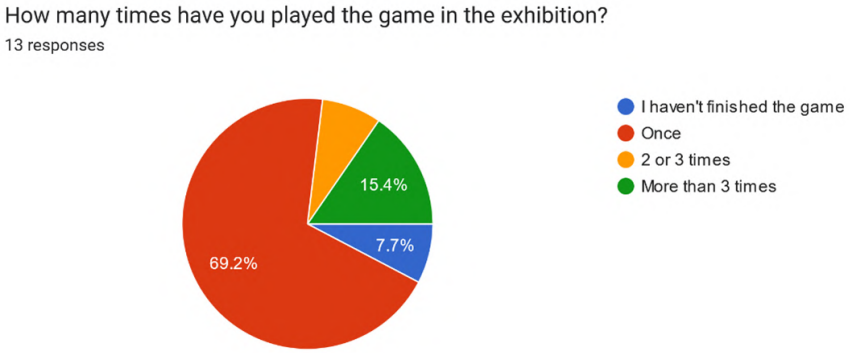

Figure 5.53: How many times have you played the game in the exhibition?

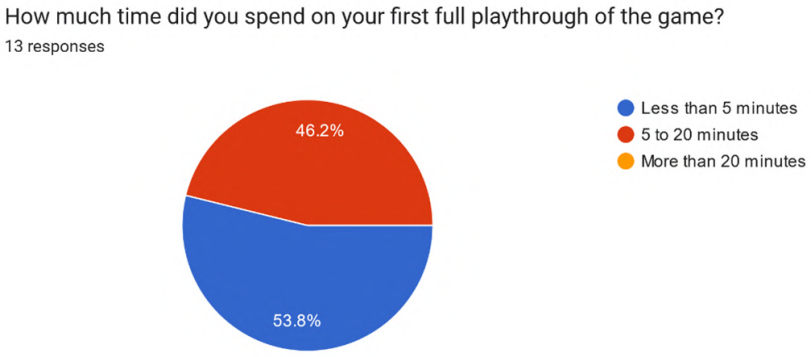

Figure 5.54: How much time did you spend on your first full playthrough of the game?

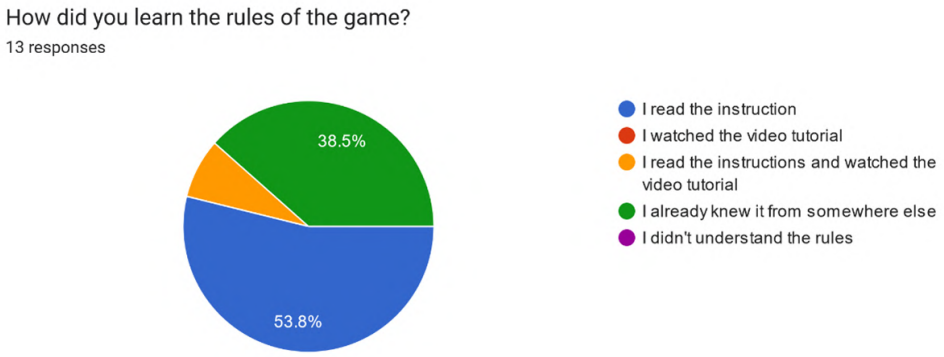

Figure 5.55: How did you learn the rules of the game?

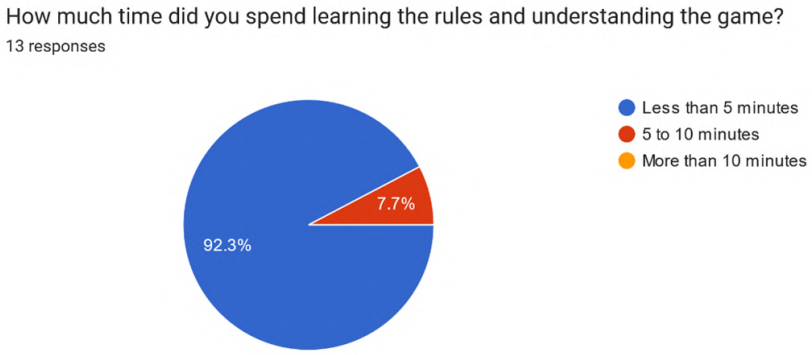

Figure 5.56: How much time did you spend learning the rules and understanding the game?

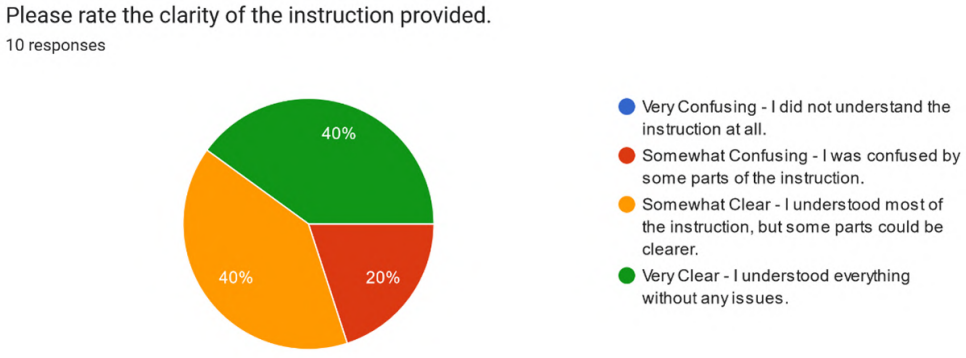

Figure 5.57: Please rate the clarity of the instruction provided.

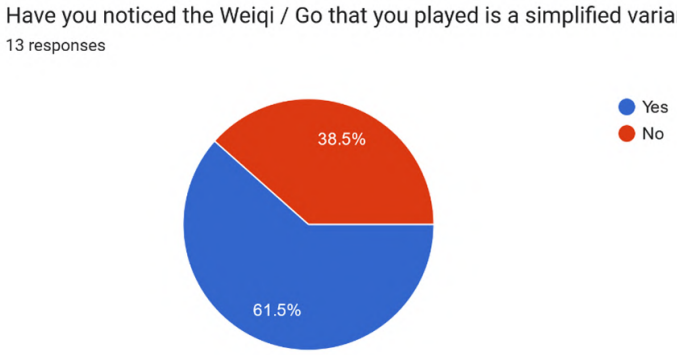

Figure 5.58: Have you noticed the Weiqi/Go that you played is a simplified variant called Atari-Go?

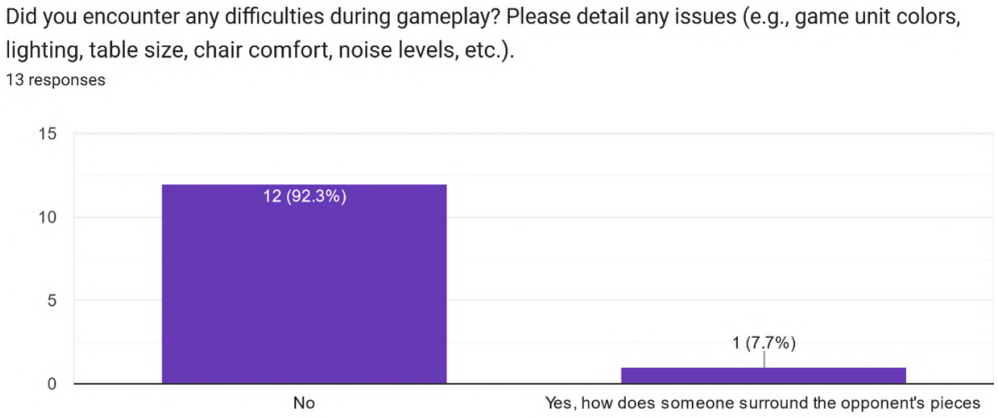

Figure 5.59: Did you encounter any difficulties during gameplay? Please detail any issues (e.g., game nit colours, lighting, table size, chair comfort, noise levels, etc.).

5.2.2.6 Shagai

Shagai was the most played game in the exhibition, with 58.3% of participants trying it, and it received an average rating of 3.95/5. Its popularity can be attributed to its fun and engaging nature, as well as its simplicity, which made it easy for participants to learn and play multiple times. Many players appreciated the coloured game pieces as a fun addition, though some struggled to distinguish between the sides, particularly with the black and white pieces. Suggestions to improve gameplay included numbering the sides instead of naming them, which could make the pieces easier to identify. The flicking mechanic was another area of concern, with some players experiencing discomfort or sore fingers, especially when playing for extended periods. Clearer instructions or demonstrations on the correct flicking technique could help address this issue. Practical suggestions, such as providing tools like a

net to assist in throwing the pieces or using rotating tables to improve comfort, could enhance the overall experience. Despite these minor challenges, Shagais replayability and accessibility made it a highlight of the exhibition.

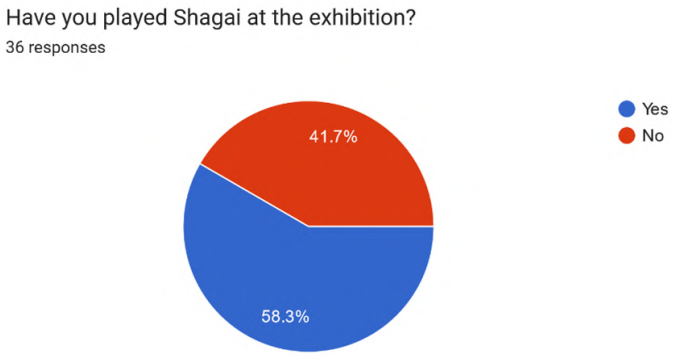

Figure 5.60: Have you played Shagai at the exhibition?

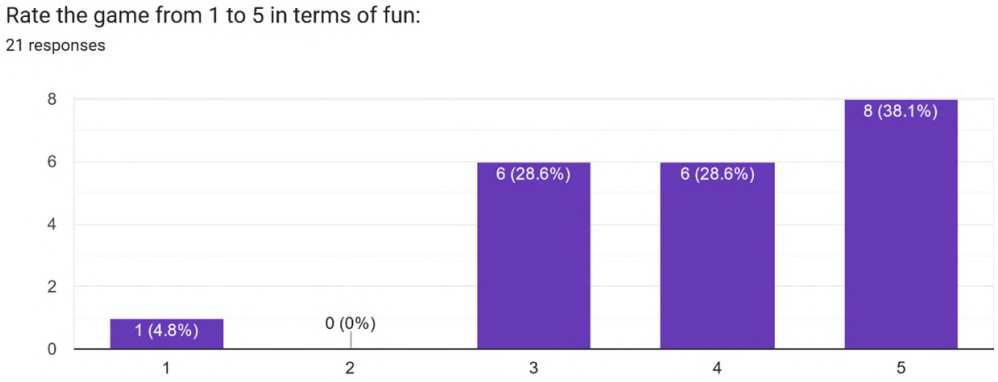

Figure 5.61: Rate the game from 1 to 5 in terms of fun.

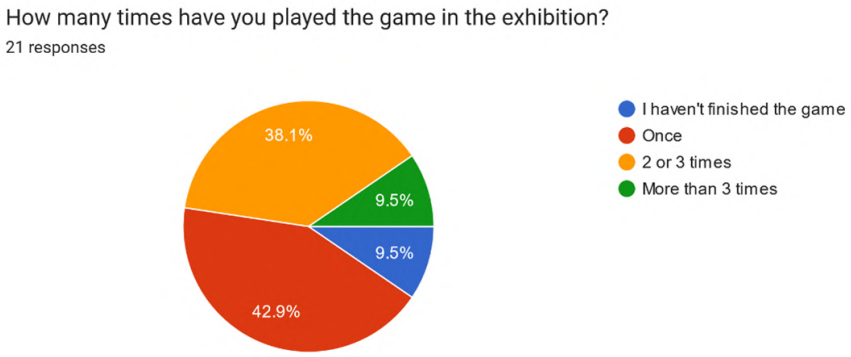

Figure 5.62: How many times have you played the game in the exhibition?

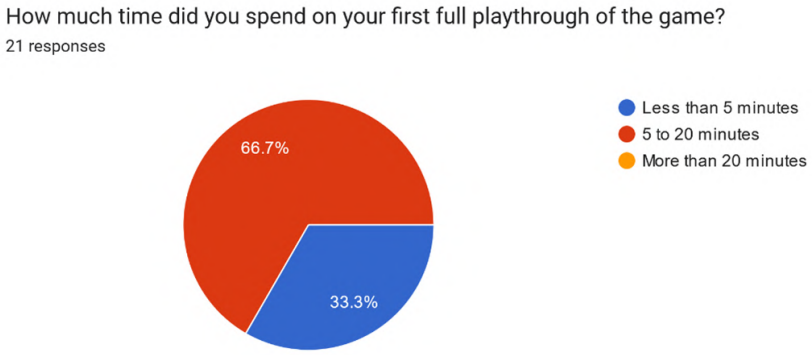

Figure 5.63: How much time did you spend on your first full playthrough of the game?

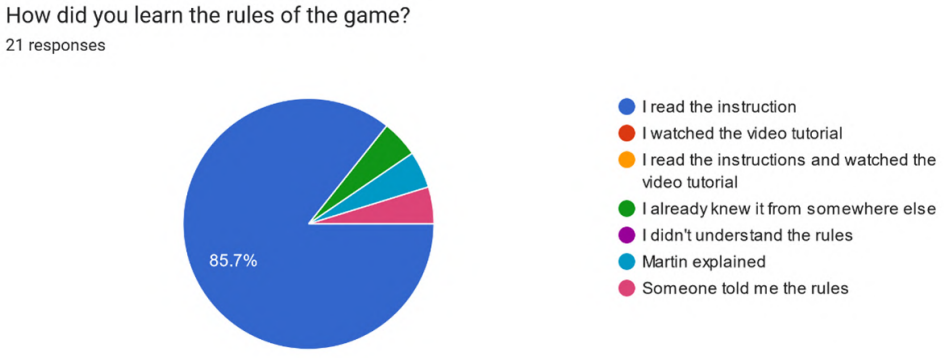

Figure 5.64: How did you learn the rules of the game?

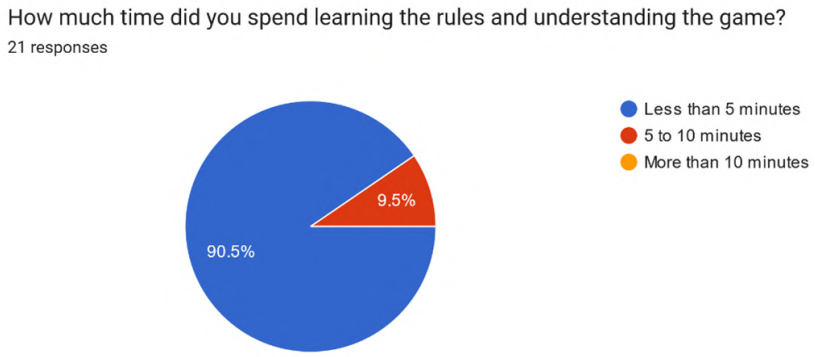

Figure 5.65: How much time did you spend learning the rules and understanding the game?

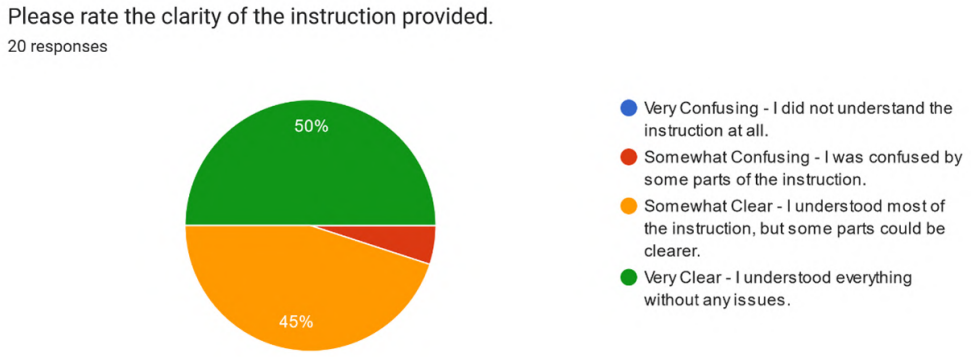

Figure 5.66: Please rate the clarity of the instruction provided.

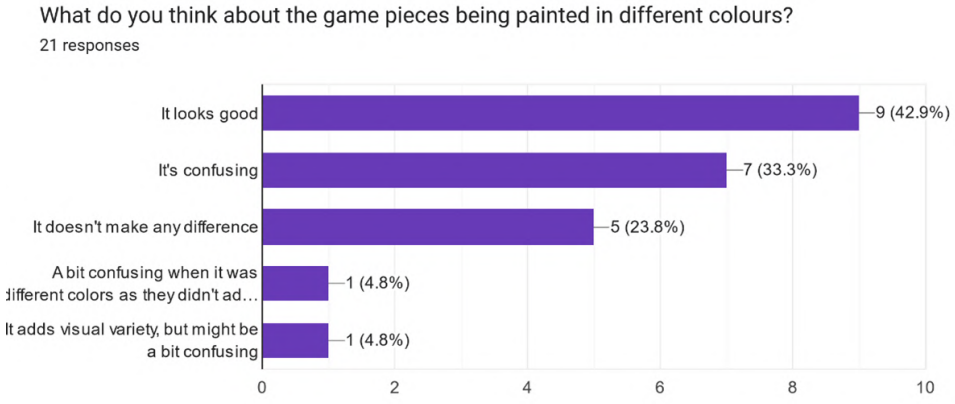

Figure 5.67: What do you think about the game pieces being painted in different colours?

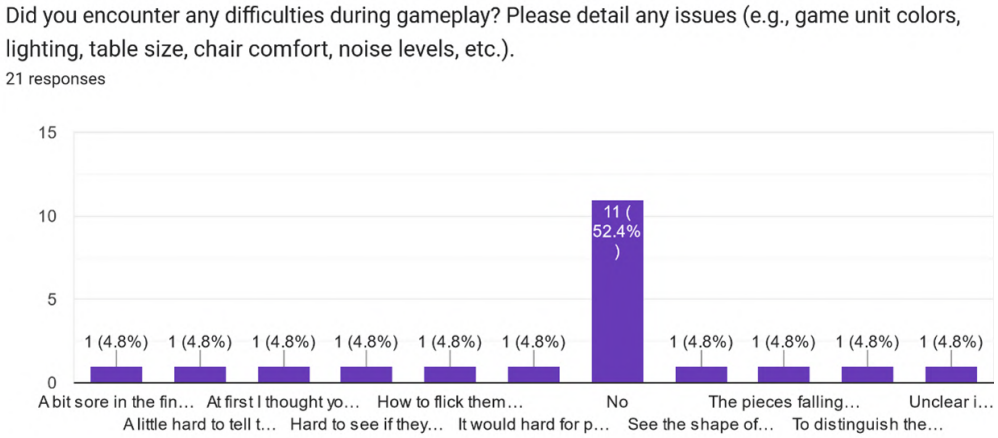

Figure 5.68: Did you encounter any difficulties during gameplay? Please detail any issues (e.g., game nit colours, lighting, table size, chair comfort, noise levels, etc.).

5.2.2.7 Senet

Senet was the least played game, with only 13.9% of participants engaging with it, but it received a high average rating of 4/5, indicating that those who played found it enjoyable. Visitors appreciated its balance of strategy and luck, as well as the unique dice mechanics, which added an element of unpredictability to the gameplay. However, some participants initially struggled to understand the dice mechanics and how to calculate steps, suggesting a need for clearer explanations or demonstrations. All players completed the game within 520 minutes, making it suitable for the exhibitions format. Given its positive reception among those who played, Senet could benefit from increased promotion and a stronger introduction to draw in more participants. Highlighting its historical significance and offering a brief demonstration of its mechanics could make it more appealing and accessible to a wider audience.

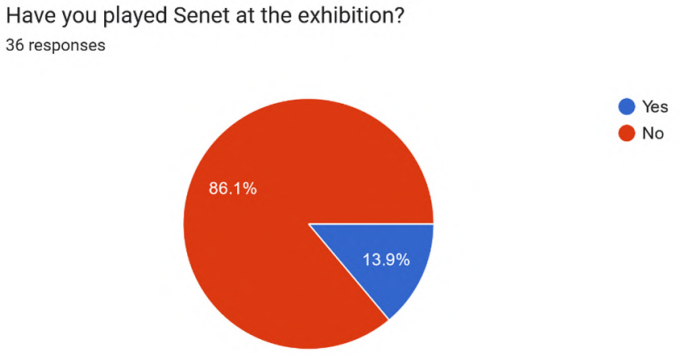

Figure 5.69: Have you played Senet at the exhibition?

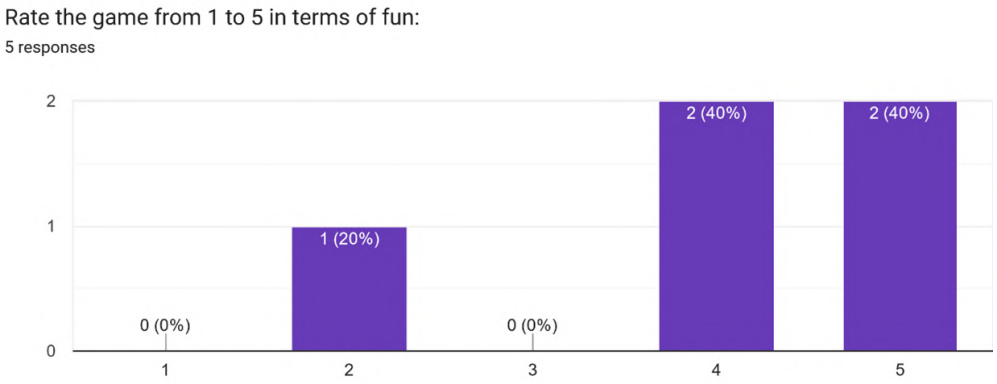

Figure 5.70: Rate the game from 1 to 5 in terms of fun.

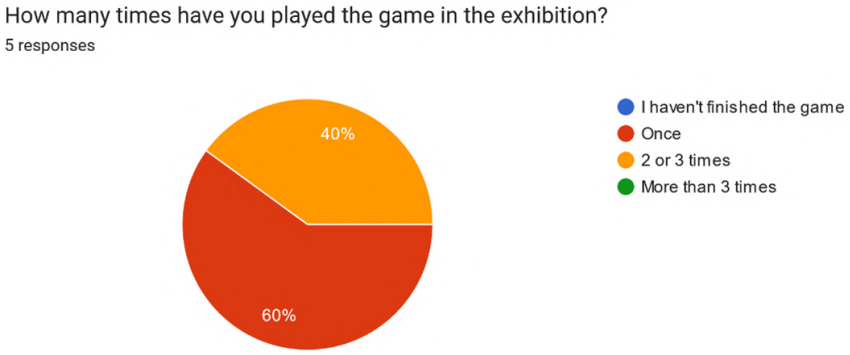

Figure 5.71: How many times have you played the game in the exhibition?

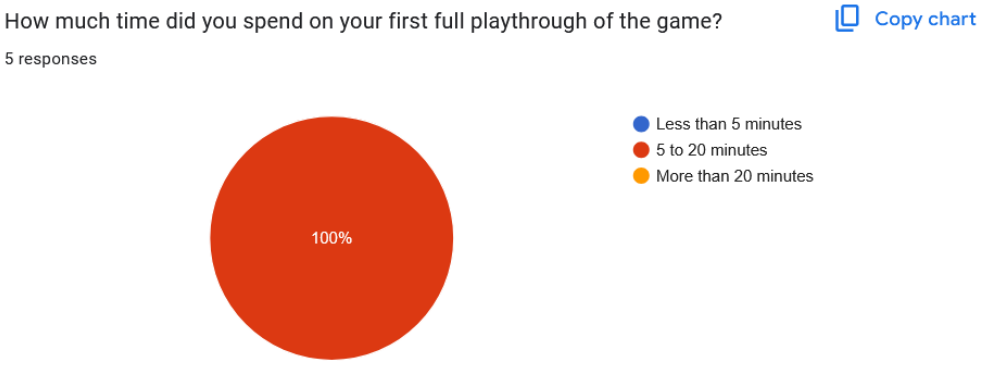

Figure 5.72: How much time did you spend on your first full playthrough of the game?

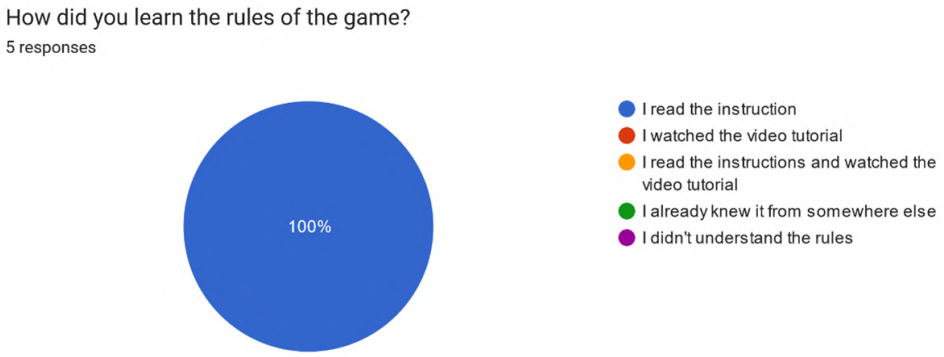

Figure 5.73: How did you learn the rules of the game?

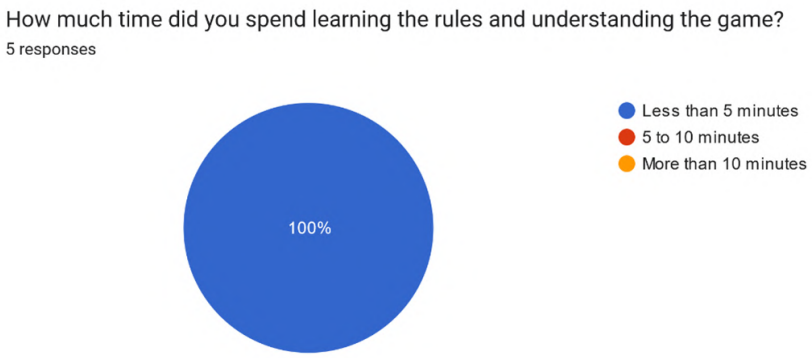

Figure 5.74: How much time did you spend learning the rules and understanding the game?

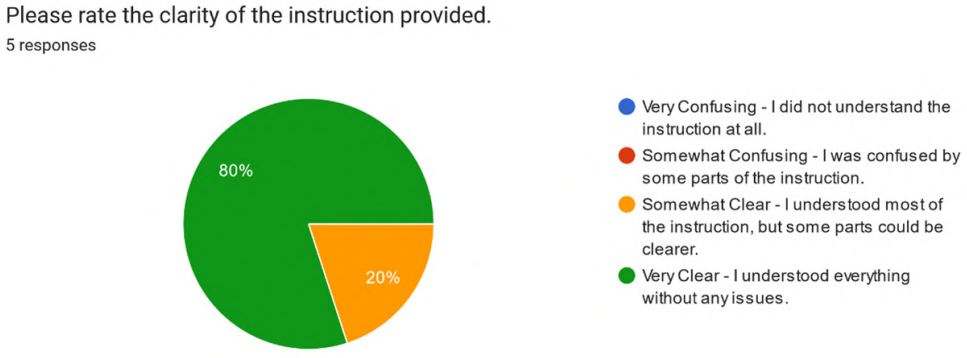

Figure 5.75: Please rate the clarity of the instruction provided.

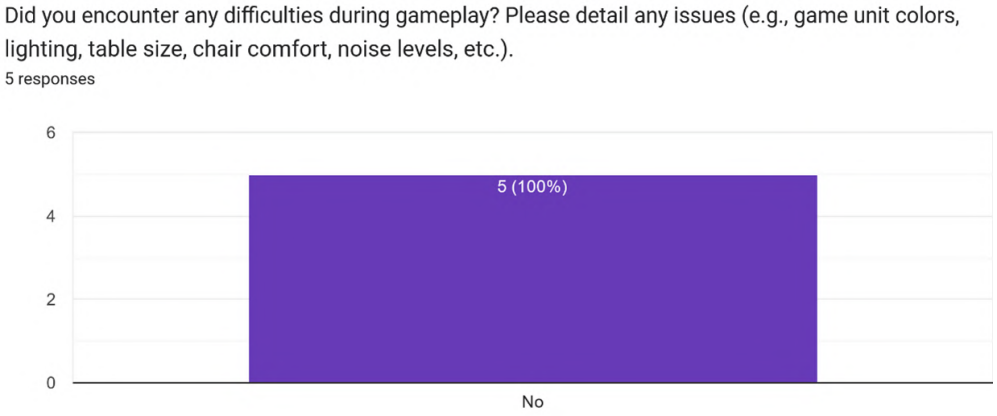

Figure 5.76: Did you encounter any difficulties during gameplay? Please detail any issues (e.g., game nit colours, lighting, table size, chair comfort, noise levels, etc.).

5.3 Interviews

As part of our thesis, we also conducted semi-structured interviews with four visitors to gather qualitative insights on their experience with the 'A World of Games' exhibition. These interviews, consisting of open-ended questions, allowed the participants to freely share their thoughts and reflections on various aspects of the exhibition. The aim was to understand how the games were perceived in terms of accessibility, enjoyment, and overall design, as well as to identify any challenges or areas for improvement. The feedback collected provides valuable perspectives on both the content and the user experience of the exhibition.

One visitor expressed a strong preference for the Japanese card game Mekuri, highlighting their enjoyment of playing with cards. Another visitor mentioned Shagai as their favourite game, appreciating its simple rules and the fact that it can be played anywhere. A third person also favoured Mekuri, noting its portability due to only needing cards. This visitor, however, found Shagai more engaging towards the end of the game, when fewer tokens are left. They also suggested that the seating or table used for Shagai should be able to rotate, allowing players to stay seated while adjusting their view to play more comfortably.

Overall, the exhibition was praised for its ability to showcase the history and development of games from around the world. However, one downside mentioned was the overwhelming number of games, which made it difficult for visitors to fully experience everything in a short visit. Some visitors found that while Mekuri's rules became easy to follow after playing for a while, the process of initially reading and understanding them was challenging. They suggested adding examples, pictures, or adding more examples in the film tutorial and making available in different languages to improve clarity. Additionally, they pointed out that the game instructions included estimated playing times but not the time needed to learn the rules, which

sometimes made the overall experience feel longer and potentially tiresome.

Some games in the exhibition only provided minimal information, often just text and pictures, which left gaps in the understanding of how certain older games were played. For example, one game mentioned the use of sticks, but there was no clear explanation of how they were used in the gameplay. One interviewee noted their dislike of reading lengthy rules and speculated that younger children might also be disinclined to read through them, advocating for shorter and more concise instructions.

In terms of accessibility, some visitors initially struggled with distinguishing between the black and blue colours in Mekuri, although they adjusted to it over time.

With Shagai, the visitors had mixed opinions on the game pieces. Some found it difficult to distinguish which side of the piece was up, especially with the white and black pieces. While some struggled with the broader flat sides, others experienced difficulty with the opposite sides. However, the coloured pieces in Shagai were seen as a fun element rather than a source of confusion. One visitor felt that the names of the animals associated with the pieces were unnecessary, suggesting that numbers would make it easier to identify the sides.

When asked about it, several practical issues were raised concerning the gameplay of Shagai. For instance, some visitors found it difficult to hold all the pieces together when throwing them, resorting to splitting the set in two. They believed 30 pieces to be a good number, as reducing the amount would shorten the game too much. A suggestion was made to provide tools, such as a net, to help throw the pieces more effectively. Additionally, flicking the Shagai pieces led to sore fingers for some players, and they expressed a need for clearer instructions on the correct flicking technique, including which finger to use.

When asked about potential improvements to the exhibition, one visitor suggested that the lighting could be brighter, as the current setup made the experience feel somewhat tiring. Another visitor expressed general satisfaction with the exhibition but wished for more time to fully explore all the games. They also noted that the artificial intelligence in some games was quite challenging. However, this was presented as a neutral observation rather than a specific critique, leaving it open to interpretation as either a positive or negative aspect of the experience depending on the player's preference.

5.3.1 Mekuri Score Calculator

We designed an app for the card game Mekuri, named the "Mekuri Score Calculator App", in response to user feedback, with the goal of improving the overall experience of the game. We chose to improve Mekuri. A significant portion of its players expressed frustration with the colour on the card and the scoring system. Based on Mekuri data, 46% of the players reported that scoring was not straightforward, and one person even found it very difficult. Recognizing the potential frustration this could cause, we decided to create an app to streamline the point-counting process and make the game more enjoyable for everyone.

Initially, we built the app using a web camera with colour detection, but later switched to image recognition to enhance accuracy and stability. After extensive internal testing, we developed the front-end using HTML and integrated it with a Python Flask back-end, allowing it to run smoothly on any mobile phone browser using the mobile phone's back camera. This ensures that the app is universally accessible, regardless of whether the user has an Android or an Apple device.

5.3.2 Color matching Approach

This approach was chosen for its simplicity and efficiency, particularly for detecting objects with a distinct colour profile.

Observed Performance:

- Accuracy: During testing, the colour detection method demonstrated high accuracy in scenarios where the target object had a unique and well-defined colour that contrasted sharply with the background. The method successfully detected the object and tracked its position in real time.
- Sensitivity to Lighting: It was observed that the effectiveness of colour detection was significantly influenced by lighting conditions. Under consistent lighting, the method performed reliably; however, changes in lighting, such as shadows or reflections, occasionally led to false positives or missed detections.
- Environmental Interference: The presence of other objects with similar colours in the scene sometimes caused the application to mistakenly identify those objects as the target. This highlighted a limitation of the colour-based approach, particularly in cluttered or dynamic environments.

5.3.3 Conclusion

The colour detection approach provided satisfactory results in controlled environments with consistent lighting and clear colour differentiation. However, its sensitivity to environmental factors limits its application in more complex or variable conditions.

5.3.4 pattern matching Approach

This approach aimed to offer greater accuracy and robustness, particularly in identifying objects regardless of scale, orientation, or lighting conditions.

Observed Performance:

- Initial Expectations: The pattern recognition method was expected to deliver high accuracy by leveraging advanced feature detection algorithms such as SIFT, combined with robust matching techniques using FLANN. Under controlled conditions, the application successfully identified the target object at varying angles and distances, provided the object was close enough to the camera.

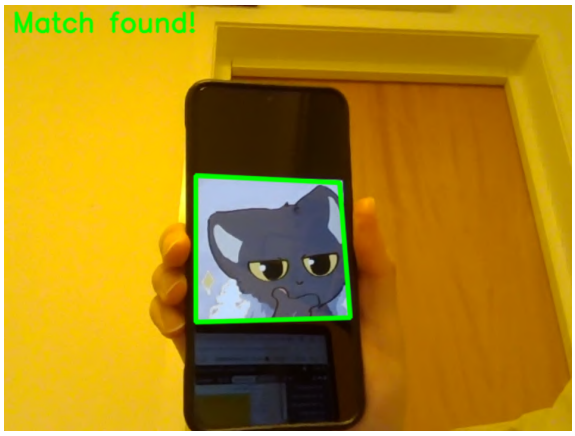

Figure 5.77: Detection succeeded at close range

- Challenges with Distance: Despite the robustness of the method to changes in scale and orientation, significant limitations were encountered when the object was far from the camera. As distance increased, the accuracy of the detection decreased substantially. The feature descriptors became less reliable and the number of good matches dropped, leading to frequent detection failures.
- Real-World Implications: The inability to reliably detect the target object from a distance severely impacted the practical usability of this approach. In real-world scenarios, where the distance between the camera and the object could vary, the application failed to provide consistent and accurate results. This limitation made the image recognition method impractical for applications that require reliable detection across a range of distances.

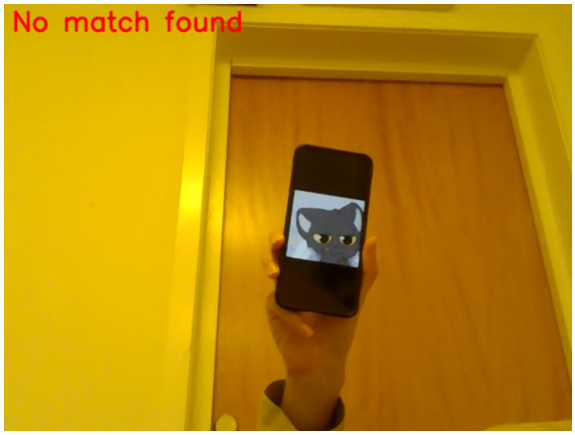

Figure 5.78: Detection failed at long range

6

Results

In this chapter, we present the results obtained from developing and testing two versions of the application: one based on colour detection and the other on image recognition. Both methods were evaluated in terms of their effectiveness in detecting specific objects within a video feed, considering factors such as accuracy, robustness, and real-time performance. Following this, we detail our data collection processes and functional testing methodologies, and provide a comparative analysis of the two applications' strengths and limitations. Using what we learned from the project and the data we gathered, we provide the answer to our main research question at the end of this chapter.

6.1 Results

Before sharing the analysis of the results, it is essential to highlight a few known limitations that we were unable to address due to technical and hardware constraints:

- Card Detection Range: The app struggles to detect cards that are placed far from the camera. As a result, the system performs best when cards are closer to the camera.
- Latency and Video Stuttering: The app uses the phone's back camera for video capture, but the back-end processing occurs on a laptop. This setup introduces network latency when moving the camera, leading to video stuttering, which impacts the smoothness of the detection process.

6.1.1 Data Collection

We employed a combination of semi-structured interviews and direct observation to gather feedback from eight participants. The demographics of the participant pool consisted of one youth (age 13), three young adults, two middle-aged individuals, and two elderly individuals, covering a diverse group of people. The semi-structured interviews allowed us to ask open-ended questions while also probing deeper into specific aspects of their experiences with the app. Additionally, we observed participants during their interaction with the app, noting their behaviours, challenges, and overall engagement.

The data collected primarily consists of qualitative feedback, focusing on the partic-

ipants' thoughts on the apps usability, effectiveness, and potential areas for improvement. Observational data complemented the interview insights, providing context for how users engaged with the app in real-time.

6.1.2 Data Analysis

One of the key behaviours we observed during testing was that all eight participants used the app to detect Mekuri patterns at a relatively close distance. None of the participants stood up or attempted to interact with the app from a long distance. This was an encouraging finding, as the app is known to perform poorly when the cards are far from the camera, and this behaviour aligned with our expectations. The close proximity ensured better detection accuracy, minimising the impact of one of the apps known limitations.

Another significant issue we encountered was related to the environment in which the app was tested. The museum where the game is placed has a dark atmosphere, and unfortunately, there is a lamp directly above the Mekuri game that casts strong shadows. These shadows made it difficult for the app to detect cards accurately, frustrating participants as they struggled to find the right angle for score calculation. This issue highlights how external conditions, particularly lighting, can have a significant impact on the performance of the app, especially given its reliance on image recognition.

When asked about the usability of the app, all eight participants responded that they found it easy to use and intuitive. None of the participants felt the need for formal instructions, as the app's design was straightforward enough to use without guidance. However, when prompted about adding instructions for accessibility, the participants expressed a preference for incorporating instructions into the games rules rather than the app itself. They believed that adding instructions directly into the app would clutter the interface and make it feel unnecessarily bloated, which might detract from the user experience.

Participants had mixed feelings about the app's usefulness in calculating scores. six out of eight participants felt that the app did not significantly help with scoring and remarked that, they brought up a point that during board games, players typically prefer to avoid using their phones. They found that using the app felt redundant and detracted from the traditional board gameplay experience. However, one participant with slight colour blindness pointed out that the app could be particularly helpful for people with visual impairments or cognitive difficulties. Another participant, although they don't have any issues themselves with playing the game, said the app could be extremely useful for their child with autism, helping them calculate the score and enjoy the game. While the app may not be essential for everyone, it has the potential to be a useful tool for individuals who face challenges in traditional gameplay. Regarding the younger participants, one mentioned that they felt comfortable doing the maths on their own and would not use the app, as it took away from from the playing experience. However, the other participant stated that they might use the app occasionally.

The natural inclination of participants to use the application at a close distance was a positive outcome, as it aligned with the application's strengths in detecting nearby objects. This behaviour also minimised the impact of the known detection range limitation, suggesting that users will likely use the app in ways that optimise its performance without explicit guidance.

The lighting issue in the museum revealed a significant challenge that affected the applications ability to function correctly. The combination of a dim environment and the shadow cast by the overhead lamp created conditions where accurate card detection became difficult. This finding underlines the importance of environmental conditions in the app's overall functionality and suggests that future iterations should consider improvements to handle low-light scenarios more effectively.

The general sentiment was that the app did not enhance the scoring process for most players and felt unnecessary during traditional board game play. However, there is a potential niche for the app among players with specific needs, such as those with visual impairments or cognitive challenges. This suggests that the app's value may be more pronounced when catering to accessibility needs, offering a clear path forward in refining its purpose.

6.1.3 Summary of Results

The image recognition approach, while theoretically robust and accurate under controlled conditions, demonstrated significant limitations in practical use due to its high latency. Despite various adjustments and optimisations, the method could not achieve reliable detection when the object was far from the camera. This limitation restricts the applications usability in real-world scenarios where distance can vary, ultimately making this approach impractical for deployment in such environments.

The testing offered valuable insights into the real-world performance of the app, shedding light on both its strengths and weaknesses. While the app was easy to use and functioned well at close distances, external factors like lighting and the perceived redundancy of using a phone during gameplay impacted its reception. However, the app shows potential as a tool for improving accessibility, especially for individuals with specific impairments. These findings provide a clear direction for future iterations of the app, focusing on enhancing robustness in various environments and addressing the needs of a more targeted user base.

6.2 Answer to the Research Question

In reinterpreting ancient games for a museum environment, it is important to consider a variety of accessibility factors to ensure that these games can be enjoyed by a broad audience, including individuals with diverse needs. Museums aim to engage visitors by offering educational and immersive experiences, but without careful design considerations, some visitors may encounter barriers to fully participating in these experiences. These barriers often arise from physical, cognitive, and sensory limitations, which can hinder access to interactive exhibits, such as ancient games.

In this section, we explore the key factors that must be taken into account when reinterpreting ancient games for maximum accessibility, along with the solutions developed during this project to address these challenges.

6.3 Accessibility Recommendations

Visual accessibility recommendations

Recommendation: Use bright, diffused lighting

Description: Dim lighting creates shadows that make it difficult to see game boards and pieces clearly. Brighter, diffused lighting improves visibility without causing glare.

Example: Visitors had difficulty seeing the board and pieces when playing Chaturaji under current lighting.

Applying the recommendation: Replace directional spotlights with diffused lighting options, such as LED panels or soft lamps. Choose exhibition spaces with access to natural light or retrofit existing lighting with higher-lumen, low-glare alternatives.

Recommendation: Use high-contrast colours

Description: Incorporate high-contrast colours for each side of the game pieces to enhance visual distinction.

Example: The two types of Weiqi pieces have a high contrast between them, and with the board, making it easy for players to differentiate between them.

Applying the recommendation: Assign strong, distinct colours to different game components. Ensure that colours are chosen based on accessibility standards, such as colour blindness simulators.

Recommendation: Use colour-blind filter tools during design

Description: Colours should be tested for accessibility, ensuring they are suitable for individuals with common forms of colour blindness.

Example: Ganjifa suits that were initially difficult to distinguish under colour-blind filters could be redesigned with better contrast.

Applying the recommendation: Use tools like colour-blind simulators (e.g. CVSimulator) when choosing colours for any element in the exhibition.

Instructional accessibility recommendations

Recommendation: Provide rules in multiple formats

Description: Clear, simple instructions ensure all visitors can quickly understand the gameplay.

Example: Rules for all seven playable board games were printed, and provided via QR code, enabling users to choose their preferred learning format.

Applying the recommendation: Offer written guides, illustrated manuals, and video tutorials. Use QR codes to link to digital materials for personal devices.

Recommendation: Use plain language and visual aids

Description: Use plain language and visual aids to ensure instructions are accessible for children, non-native speakers, and individuals with cognitive challenges.

Example: Senet and Chaturaji instructions with visual cues helped players who were unfamiliar with the grid system.

Applying the recommendation: Include simple vocabulary, icons, and step-by-step images in instructions across all games.

Game design for usability recommendations

Recommendation: Design ergonomic components

Description: Game pieces should be designed for easy handling.

Example: The Shagai ankle bone holder would make it easier for children and players with limited dexterity to gather and serve all 30 pieces.

Applying the recommendation: Provide supportive tools like scoops, trays, or other types of piece holders. Choose materials and shapes that are lightweight and fit comfortably in hand, but still respect the games' origins.

Recommendation: Shorten gameplay duration

Description: Shorter gameplay sessions (1020 minutes) prevent fatigue and allow more visitors to participate.

Example: Quick-play rules for Weiqi made the game more engaging for drop-in visitors.

Applying the recommendation: Provide simplified rule variants with estimated play time labels.

Recommendation: Allow flexible player count

Description: Design games to support variable numbers of players.

Example: Ganjifa was less interesting when played by only two people.

Applying the recommendation: Include suggestions for solo play, pairs, or larger group variants in game instructions.

Informational design recommendations

Recommendation: Present historical context clearly

Description: Display engaging and accessible information about the history and cultural significance of each game.

Example: Explanation by museum guides about the Ganjifa cards made visitors more interested in their origins.

Applying the recommendation: Provide visual or auditory storytelling formats near game stations.

Recommendation: Position information near gameplay area

Description: Ensure information is located near the game area, making it easy for players to reference without disrupting gameplay.

Example: Placing instructions directly beside the board games increased engagement and reduced confusion. However some visitors noted that it would be better if the instructions were on the table.

Applying the recommendation: Mount readable signage or provide tablets right next to the physical game setup.

Visitor engagement recommendations

Recommendation: Offer activities while waiting

Description: Offer engaging activities near game stations to keep visitors occupied while waiting to play.

Example: Visitors waiting to play Senet were losing interested in the game, but this could be solved with shorter activities nearby or a brief explanation of the game by museum guides.

Applying the recommendation: Provide light activities such as digital versions, puzzles, or quizzes nearby.

Inclusive environment recommendations

Recommendation: Design adaptable spaces

Description: The physical layout must be navigable, comfortable, and safe for all visitors, including those using mobility aids or requiring additional space.

Example: Rotatable seating and wide walkways near the playable allowed wheelchair users to approach and interact with the exhibits.

Applying the recommendation: Maintain at least 150 cm wide paths, use smooth flooring, and provide accessible seating with arm and back support.

Recommendation: Provide sensory-friendly zones

Description: Provide tactile features and clear signage for a more inclusive experience.

Example: Areas where visitors could just take a rest were frequently used by visitors who stayed longer in the musuem.

Applying the recommendation: Use designated quiet areas or signs indicating low-sensory zones.

Prototyping and feedback recommendations

Recommendation: Conduct user testing with diverse groups

Description: Involve diverse user groups in testing game designs.

Example: Elderly visitors and children tested Shagai and gave feedback that helped improve the shape and function of the bone holder.

Applying the recommendation: Run iterative testing with groups representing various age ranges, abilities, and backgrounds.

Recommendation: Use inclusive co-design

Description: Collaborate with accessibility experts, educators, and representatives of different communities during the design process.

Example: Create tactile markers for Ganjifa cards.

Applying the recommendation: Organise co-design sessions or interviews early in development, and revisit throughout.

Interactive features recommendations

Recommendation: Use clear and distinct interface elements

Description: It can be difficult to distinguish between back buttons, which exit a game or screen, and undo buttons, which reverse an action. Clear differentiation helps avoid confusion and interruptions.

Example: Confusion around buttons in some interactive screens led to gameplay interruptions.

Applying the recommendation: Use universal icons and distinct colours, and place the buttons in fixed, intuitive locations.

Recommendation: Provide multilingual support with consistency

Description: All text, video, and audio content should be fully aligned across both languages.

Example: Visitors noted that some content on the screens was available in English but missing or different in Swedish.

Applying the recommendation: Conduct quality checks and ensure accurate translations across all interface elements.

Recommendation: Add captions and sign language

Description: Captions should be added to all videos and audio files, available in both English and Swedish.

Example: Deaf and hard-of-hearing visitors were better able to engage with the videos when captions were included.

Applying the recommendation: Integrate clear, synchronised captions and optional sign language interpretation into all relevant media.

Recommendation: Indicate system feedback clearly

Description: Lagging screens can cause delays in gameplay and navigation. Clear system feedback improves the user experience.

Example: Visitors were uncertain whether the screen had frozen or was loading.

Applying the recommendation: Add animations or status indicators during longer loading phases.

Maintenance and updates recommendations

Recommendation: Use durable and cleanable materials

Description: The modifications should be durable and easy to clean, preserving the integrity of the pieces while maintaining hygiene in a public setting.

Example: Huuchuish pieces are made with non-toxic coatings, making them both safe and durable.

Applying the recommendation: Choose hypoallergenic resins, silicone, or wood with sealants suitable for frequent handling and cleaning.

Recommendation: Update content and features regularly

Description: Periodic updates help ensure that all components remain functional, accurate, and accessible to a broad range of users over time.

Example: Chaturajis instructions were updated in the past after repeated confusion was observed, leading to smoother gameplay.

Applying the recommendation: Establish review cycles for checking usability issues and refreshing materials.

Cultural and aesthetic integration recommendations

Recommendation: Balance authenticity with accessibility

Description: While incorporating modern accessibility features, respect the cultural and historical roots of the games.

Example: The wooden finish of the proposed Shagai holder contributes to accessibility fits the overall look and feel of the game, while preserving its traditional charm.

Applying the recommendation: Use materials and design motifs appropriate to the games culture while integrating modern functional enhancements.

Recommendation: Use storytelling and visuals to enhance engagement

Description: Present games and their histories in a visually compelling way that captures cultural and educational value.

Example: Visitors connected more with some exhibits when short text or a guide explained how it was used in diplomacy.

Applying the recommendation: Supplement physical game setups with thematic storytelling panels, comic strips, or interactive narratives.

6.4 Summary of Recommendations

In conclusion, designing accessible and user-friendly exhibitions for ancient games requires careful consideration of various factors, including visual and instructional accessibility, usability, engagement, and inclusivity. By addressing these areas, museums can create environments where visitors of all abilities can interact meaningfully with the exhibits. Integrating ergonomic design, comprehensive instructions, and cultural authenticity ensures that the games remain enjoyable and educational while honouring their historical significance. Furthermore, involving diverse user groups during the design process and maintaining the exhibition through regular updates help ensure its relevance and inclusivity over time.

By implementing these guidelines, museums can foster a welcoming and engaging space that celebrates the rich heritage of ancient games, offering all visitors an opportunity to learn, play, and connect with history in an accessible and inclusive way.

7

Discussion

In this discussion chapter, we focus on the design solutions and improvements proposed for the games featured in the exhibition, as well as the exhibition setups themselves. Our aim was to evaluate these elements critically and address our research question by analysing the effectiveness of these solutions.

7.1 Results Discussion

This section reflects on the accessibility solutions and design recommendations presented in the Guidelines chapter, placing them within a broader interpretative context. Rather than reiterating the specific interventions described earlier, this discussion focuses on the rationale behind the design decisions, the challenges encountered, and the wider implications for inclusive exhibition design.

The accessibility solutions proposed throughout this project were not intended as isolated technical fixes but as part of a holistic effort to ensure that ancient games can be meaningfully experienced by as diverse a visitor group as possible. By addressing physical, cognitive, sensory, and linguistic barriers, the solutions demonstrate how universal design principles can be applied to cultural heritage settings. In particular, we recognised the importance of allowing users to engage with games independently, using tools and adaptations that preserve the spirit of play without compromising clarity, comfort, or dignity.

Several themes emerged during the development of the guidelines. First, the value of tactile and multi-sensory feedback proved especially important in games involving physical components. Features such as engraved boards, textured pieces, and consistent card layouts not only aid users with visual impairments but also enhance the experience for all visitors by offering a richer, more tangible interaction with the exhibits.

Second, clarity of instruction and interface design emerged as a recurring challenge. Museum visitors include individuals of all ages, backgrounds, and cognitive abilities, and they typically interact with exhibits for a limited amount of time. This constraint required us to prioritise intuitive design and streamlined communication. The goal was not merely to simplify but to accommodate a wide range of literacy levels, language skills, and familiarity with digital interfaces.

Third, co-design and iterative feedback proved essential. Although not all proposals

could be prototyped and tested in the museum setting within the scope of this thesis, our reliance on accessibility literature, museum staff insights, and preliminary user observations highlighted the need for early and sustained engagement with diverse stakeholders. Such collaboration supports the development of solutions that are not only technically feasible but also culturally appropriate and socially inclusive.

Finally, we emphasise that accessibility is not a static checklist but an ongoing process that should evolve alongside visitor needs and technological advancements. The recommendations presented in the Guidelines chapter form a strong foundation, but future iterations will benefit from continued user testing, updates in assistive technologies, and institutional commitment to inclusive design practices.

In summary, this discussion highlights how a thoughtful, user-centred approach to accessibility can strengthen both the educational and experiential value of museum exhibitions. By reinterpreting ancient games through this lens, museums can preserve historical authenticity while expanding access to cultural knowledge and play for all.

7.2 Process Discussion

This project followed a clear and step-by-step process to explore how tabletop games can be made more accessible in museum exhibitions. We began by learning about the ancient games included in the exhibition and evaluating their accessibility using tools like Accessibility Tear-down and Universal Design. To understand visitor experiences and needs, we collected data through questionnaires and semi-structured interviews. Based on the results, we chose three games to focus on and designed solutions to address the challenges we identified. These solutions were meant to be tested and improved based on feedback. The goal was to analyse the findings and share them in this report. Some of the solutions included changes in the games, the physical space around them, the interactive screens, but for Mekuri, we also made a mobile application to support players.

To support this process, we used Agile Project Management. Although Agile comes from software development, it worked well for this project because it focuses on people, flexibility, and ongoing collaboration. The Agile approach helped us involve different stakeholders, such as museum visitors, staff, and university advisors, throughout the process. Instead of relying only on theories or assumptions, we aimed to include those who would be directly affected by our work.

Agile's flexibility also made it easier to adapt our ideas as we received feedback. This was especially helpful compared to more rigid methods like the Waterfall model, which only include user input at fixed stages. However, we did face some challenges. For example, we created a prototype of an app for the Mekuri game, but it struggled to detect objects from a distance. Time limitations and the wide scope of the project also meant that some of our ideas couldnt be tested or finalised. Because of this, we couldnt fully evaluate how well all the solutions would work in practice.

7.3 Generalisability and Validity

This study focused on improving accessibility for tabletop games within the *A World of Games* exhibition at Världskulturmuseet. As such, the findings were shaped by the specific conditions of this museum, including its physical layout, visitor demographics, and available resources. These factors influenced both the challenges we observed and the kinds of solutions we were able to propose.

While some of the results are closely tied to the context of this particular exhibition, many of the underlying principles, such as the importance of clear and simple instructions, tactile feedback, and flexible design, are likely to be relevant in other museum settings as well. Museums that include interactive or game-based exhibits could potentially benefit from similar design ideas, especially if they also aim to reach diverse audiences.

However, there are limits to how much our findings can be applied elsewhere. One key limitation is that the study involved a relatively small number of participants. This group does not fully reflect the wide range of people who visit museums, particularly those with long-term disabilities or access needs. Although we tried to engage with disability organisations, we were unable to involve participants with specific impairments. We used simulation tools, such as colour-blindness filters, to guide parts of the design process, but these are no substitute for real user feedback.

Another factor affecting generalisability is that technical testing was limited. For example, the Mekuri scoring app was only tested with a small group, and its performance issues were not fully resolved. Because of this, we could not evaluate how well the solutions would perform in other exhibitions with different lighting, spacing, or visitor behaviour.

In summary, while the accessibility strategies we developed are grounded in well-established principles and may inspire similar improvements in other museums, their direct transferability is limited by the studys narrow scope, small sample size, and lack of testing with key user groups. Future research in other institutions and with more diverse participants would help confirm how widely these approaches can be applied.

7.4 Future Work

As mentioned above, there are several ways this project could be continued and improved in the future. One of the most important next steps is to test the proposed design solutions with people who have different kinds of disabilities. Because we couldnt include these voices in this project, we missed the chance to learn directly from the people most affected. Future studies should focus on working closely with disabled users to better understand their needs and how the designs can be adjusted to suit them.

Another area to improve is the technology. The Mekuri app, for example, had difficulty recognising objects from a distance. Future work could look into using

better cameras or more advanced detection methods to make the app more reliable. It could also be expanded with more interactive features to make the user experience smoother and more engaging.

In addition to refining what weve already built, there are still many design ideas that couldnt be fully developed due to time limits. Future projects could choose a smaller number of games or features to focus on, allowing more time for proper testing and improvements. This would help ensure that the changes are not just good in theory, but also useful in practice.

Overall, the next steps should include deeper testing with diverse users, technical improvements, especially for the app, and continued work on ideas that could not be fully explored during this project.

7.5 Ethical Aspects

Ethical considerations were an important part of this project from the beginning. We wanted to make sure that all participants were treated with respect and that their privacy and rights were protected throughout the study.

Everyone who took part gave informed consent before participating. For children under 16, we made sure to get permission from a parent or guardian. Before recording any interviews or observations, we asked for clear consent from those involved.

During observations in the exhibition, we were careful to keep a respectful distance and not make anyone feel uncomfortable or watched. Any information collected was kept confidential and anonymised in the final report, so no individual could be identified.

Participation was always voluntary. Everyone was told they could stop at any time without needing to explain or facing any consequences. After their participation, we also aimed to offer a short explanation of the study and how their contributions would be used.

Beyond the practical side of ethics, we also thought about the broader purpose of the project: promoting fair and inclusive access to cultural spaces. This concern is reflected not only in our methods but also in the solutions we developed. We hope that our work contributes to more ethical, inclusive, and thoughtful exhibition design in the future.

8

Conclusion

In this chapter, the main outcomes of the project are summarised, highlighting how the work has contributed to improving accessibility and visitor engagement in a museum setting. The focus is on what was achieved, how it was done, and how this work can support future developments in similar contexts. Before we begin this chapter, I want to reiterate our research questions and the aim and purpose of this project. The research question is: *What should be considered when reinterpreting ancient games in a museum environment, in order to maximise inclusive and interactive experiences?*

This project aimed to improve accessibility and visitor experience in the A World of Games exhibition at Världskulturmuseet. By focusing on how tabletop games are presented and interacted with, the goal was to create a more inclusive and engaging environment for a wide range of visitors. Through research, design, and user feedback, the project developed practical ideas and tools that museums can use to support more accessible exhibitions.

The work began with an evaluation of the games using the Meeple Like Us tear down approach and Universal Design principles. This initial step helped identify where improvements could be made. Questionnaires and interviews with museum visitors added further insight, helping us understand different needs and experiences.

Based on these findings, a set of design solutions was developed. One of the key outcomes was a prototype app for the Mekuri game to help with score calculation, identified as a point of confusion for some users. In addition, design suggestions were made for other games, focusing on visual clarity, tactile feedback, and ease of understanding. These efforts were brought together in a set of guidelines that can support museums in making tabletop games more accessible and user friendly.

A comprehensive list of recommendations can be found in the Results chapter in sections 6.3. The following summarises these as a set of recommendations across different aspects of the exhibition, and can also be used for other exhibitions as a general recommendations overview:

Accessibility Recommendations Overview

- **Visual Accessibility**
  - Use bright, diffused lighting to reduce shadows and glare

  - Incorporate high-contrast colours to distinguish game elements
  - Test colours using colour-blind filters to ensure accessibility
- **Instructional Accessibility**
  - Provide game rules in multiple formats (e.g., text, visuals, video)
  - Use plain language and visual aids to support diverse users
- **Game Design for Usability**
  - Design ergonomic components for easy handling
  - Shorten gameplay duration to 1020 minutes
  - Allow flexible player counts (solo, pairs, groups)
- **Informational Design**
  - Present historical and cultural context clearly
  - Position information close to the gameplay area
- **Visitor Engagement**
  - Offer light activities near game areas to engage visitors while waiting
- **Inclusive Environment**
  - Design adaptable spaces with sufficient width and accessible seating
  - Provide sensory-friendly zones with tactile features and low noise
- **Prototyping and Feedback**
  - Conduct user testing with diverse groups
  - Use inclusive co-design methods throughout the process
- **Interactive Features**
  - Use clear and distinct interface elements (e.g., back vs. undo)
  - Ensure consistent multilingual support
  - Add captions and sign language to media
  - Indicate system feedback during loading or interaction
- **Maintenance and Updates**
  - Use durable and cleanable materials
  - Update content and features regularly
- **Cultural and Aesthetic Integration**
  - Balance cultural authenticity with modern accessibility
  - Use storytelling and visual design to enhance engagement

Summary

- Integrate accessibility considerations into every stage of exhibition design
- Ensure that physical, cognitive, sensory, and linguistic needs are met
- Emphasise co-design, feedback loops, cultural authenticity, and clarity
- Create inclusive, engaging, and meaningful experiences for all visitors

Although not every idea could be tested or finalised within the time frame, the project successfully showed how accessibility improvements can be approached through user involvement, practical design, and thoughtful use of technology. The approaches taken here can serve as a model for similar projects in other museums and exhibitions.

Looking ahead, future work could involve more direct collaboration with people who have long term disabilities, further technical development of tools like the Mekuri app, and continued testing of the proposed designs in real exhibition settings. These steps would help deepen understanding of accessibility needs and support the creation of even more inclusive museum experiences.

In summary, this project identified key accessibility challenges in the exhibition and proposed realistic, meaningful solutions. By focusing on the visitor experience and combining design with research, it provides a strong foundation for ongoing improvements in inclusive exhibition design.

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A

Appendix 1

A.1 Implementation of Score Counting App for Mekuri Using Color Detection

Many players encountered difficulties in counting their final score in Mekuri, so we decided to build a mobile web app to help them detect the cards and automatically calculate their points. We began by coding the camera to recognise the patterns on Mekuri cards.

The first version of the application was implemented using a colour-based detection technique. The core of the method consists of two parts, colour detection function and HSV (hue, saturation, and value) range and detection in the main loop.

```
def detect_color(frame, lower_color, upper_color):
    # Convert the frame to HSV color space
    hsv_frame = cv2.cvtColor(frame, cv2.COLOR_BGR2HSV)

    # Create a mask for the color using the provided HSV range
    mask = cv2.inRange(hsv_frame, lower_color, upper_color)

    # Perform a bitwise AND between the frame and mask to get the colored regions
    color_detected = cv2.bitwise_and(frame, frame, mask=mask)

    return color_detected
```

Figure A.1: Colour Detection Function

In the function in Figure A.1, `detect_color`, is central to the colour detection process in the application. It begins by converting the input image from the BGR colour space, which is the default in OpenCV, to the HSV (Hue, Saturation, Value) colour space. The HSV colour space is more suitable for colour detection as it separates chromatic content (hue) from intensity (saturation and value). The function then creates a binary mask by isolating pixels within a specified HSV range, corresponding to the target colour. Finally, it applies a bitwise AND operation between the original frame and the mask to extract and display the regions of the image where the specified colour is detected.

```
# Define the color range for detection in HSV
lower_blue = np.array([100, 150, 0])
upper_blue = np.array([140, 255, 255])

# Detect the color in the current frame
blue_detected = detect_color(frame, lower_blue, upper_blue)

# Display the original frame and the detected color frame
cv2.imshow('Original Frame', frame)
cv2.imshow('Blue Color Detected', blue_detected)
```

Figure A.2: HSV Range and Detection in the Main Loop

In the main loop of the application shown in Figure A.2, the `detect_color` function is applied to real-time video frames captured from the webcam. Before invoking the function, an HSV range is defined to specify the target colour (in this case, the range for blue is used). The function then processes each frame to identify and isolate the specified colour. The original frame and the colour-detected frame are both displayed side by side, allowing for a real-time visual comparison. This section of the code demonstrates the practical application of the colour detection logic within a continuous video stream, showing how the app responds dynamically to the defined colour parameters.

A.1.0.1 Implementation of Score Counting App for Mekuri Using image recognition

The second version of the application employed an image recognition technique, utilising feature detection and matching algorithms. This method implements a real-time object detection system using SIFT for feature detection and FLANN for feature matching. The code initializes SIFT to detect key-points and compute descriptors for a template image, sets up the FLANN matcher to efficiently compare these descriptors with those found in video frames, and then matches the template to the frames using homography to detect and highlight the template within the video feed. Each step is crucial for enabling accurate and robust pattern recognition in real-time.

```
# Initialize SIFT detector
sift = cv2.SIFT_create()

# Compute keypoints and descriptors for the template image
template_keypoints, template_descriptors = sift.detectAndCompute(template, None)
```

Figure A.3: SIFT Initialization and Key-point Detection

This part (Figure A.3) of the code initializes the SIFT (Scale-Invariant Feature

Transform) algorithm and uses it to detect key-points and compute descriptors for the template image `pattern.jpg`. Key-points are distinctive points in the image, and descriptors are vectors that describe the local appearance around each key-point. This step is crucial because it extracts the unique features of the template image, which will later be matched against features in the video frames to detect the presence of the template.

```
# FLANN parameters for feature matching
FLANN_INDEX_KDTREE = 1
index_params = dict(algorithm=FLANN_INDEX_KDTREE, trees=5)
search_params = dict(checks=100)

flann = cv2.FlannBasedMatcher(index_params, search_params)
```

Figure A.4: FLANN Matcher Setup

This section (Figure A.4) configures the FLANN (Fast Library for Approximate Nearest Neighbors) matcher, which is optimized for efficiently matching large sets of descriptors. The code sets up the matcher to use a K-D tree algorithm with specific parameters for indexing and searching. This setup ensures that the process of finding matching features between the template image and the video frames is fast and accurate, which is essential for real-time applications.

```python
if descriptors is not None:
    # Match descriptors between the template and the frame
    matches = flann.knnMatch(template_descriptors, descriptors, k=2)

    # Store all the good matches as per Lowe's ratio test
    good_matches = []
    for match in matches:
        if len(match) == 2:
            m, n = match
            if m.distance < 0.5 * n.distance:
                good_matches.append(m)

    # Draw matches if enough good matches are found
    if len(good_matches) > 20:  # Increased the threshold to reduce false positives
        # Extract location of good matches
        src_pts = np.float32([template_keypoints[m.queryIdx].pt for m in good_matches]).reshape(-1, 1, 2)
        dst_pts = np.float32([keypoints[m.trainIdx].pt for m in good_matches]).reshape(-1, 1, 2)

        # Find homography
        M, mask = cv2.findHomography(src_pts, dst_pts, cv2.RANSAC, 5.0)
        matches_mask = mask.ravel().tolist()

        if M is not None and np.sum(matches_mask) > 10:  # Additional check on the number of inliers
            # Get the corners of the template image
            h, w = template.shape
            pts = np.float32([[0, 0], [0, h], [w, h], [w, 0]]).reshape(-1, 1, 2)
            dst = cv2.perspectiveTransform(pts, M)

            # Draw the detected template on the frame
            frame = cv2.polylines(frame, [np.int32(dst)], True, (0, 255, 0), 3, cv2.LINE_AA)
```

Figure A.5: Matching and Homography Calculation

In this part (Figure A.5), the code performs the core task of matching descriptors between the template and the current video frame using the FLANN matcher. After applying Lowe's ratio test to filter out weak matches, the code calculates a homography matrix if enough good matches are found. This matrix is used to map the template onto the current frame, and if successful, the detected template's outline is drawn on the frame. This process enables the system to recognize and highlight the template in the video, even under varying conditions such as different angles or distances.

B

Appendix 2

B.1 Questionnaires

In our research, we developed two versions of the questionnaire to accommodate participants with different language preferences: one in English and one in Swedish. This ensured accessibility and clarity for all respondents. The English version of the questionnaire can be accessed **here**, and the Swedish version can be accessed **here**.

B.1.0.1 Chaturaji

17 (47.2%) of the participants said they have played Chaturaji. This means Chaturaji was the second most played game out of the seven tabletop games in the exhibition.

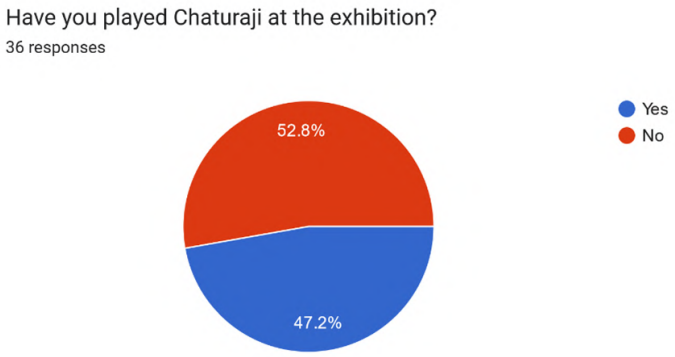

Figure B.1: Have you played Chaturaji at the exhibition?

Those 17 who played the game, were then asked to rate the game from 1 to 5 in terms of fun.

- None of them rated it with '1/5'.
- Only one person rated it with '2/5'.
- Only one person rated it with '3/5'.

- The vast majority, 12 out of 17 (70.6%), rated it with '4/5'.
- And finally 3 people rated it with '5/5'.

A majority of those who played the game found it enjoyable and rated it favourably. The average rating was 4 out of 5.

The next question was open-ended and optional. 11 out of 17 responded. To summarize their replies, the fact that it was a game similar to chess, with which they may be more familiar, but also that it is possible to play with more people. One respondent said that it is better to play Chaturaji with 4 than 2 people. One respondent who also agreed with the consensus that they liked that it is possible to play with two to four players, they noted that they disliked they had to use the dice to determine which pieces they can move. Another said that the use of dice restricted movements and freedom of play.

Most, 9, of those who played the game, did so once, while 7 people played twice or thrice. No one played more than three times, and one person did not finish playing the game. We consider these numbers to reinforce their positive responses in the previous questions.

The next question was 'How much time did you spend on your first full playthrough of the game?'. We sought to determine whether participants required more time than what we had initially estimated as adequate for a complete playthrough or whether they finished the game significantly faster than anticipated. These insights would help us evaluate the game's pacing and overall player engagement, allowing us to refine our understanding of the player experience and potentially inform future game design decisions. It is also important that the tabletop games in the exhibition can be played relatively quickly, so that visitors have the time and energy to play more games and see the rest of the exhibition, and possibly the museum. We provided three options as answers, and the results were:

- One person said they spent 'less than 5 minutes'.
- The overwhelming majority, 14 people, said that they spent between 5 and 20 minutes.
- And two people said they needed 'more than 20 minutes'.

Most of the respondents played the game during the time limits that we consider adequate for a first playthrough.

We also wanted to see how they learned the rules of the games, how much time they needed to do so, and if they thought the rules were easy to understand.

The next question was 'How did you learn the rules of the game?' and the possible answers were the following:

- I read the instructions
- I watched the video tutorial
- I read the instruction and watched the video tutorial

- I already knew it from somewhere else
- I didn't learn the rules
- Other, for which they were given a text-box to explain what they meant.

Almost all of them, 16, said they read the instructions (on the rules table next to the game), and one person selected 'Other', adding 'Martin explained'. Even though we could not ask for clarification, we believe Martin is someone who was with them and possibly played the game together with. It is unknown whether Martin knew the rules already or if they also completed the survey and was one of the sixteen people who said they read the instructions.

The next question on the survey was 'How much time did you spend learning the rules and understanding the game?', with the following as possible answers, and the number of participants who selected them:

- Less than 5 minutes: 15 participants
- 5 to 10 minutes: 1 participant
- More than 10 minutes: 1 participant

Most participants did not need much time to learn and understand the rules of the game, and that is a positive outcome.

In the following question, the majority replied that the instructions were 'very clear' (7 participants, 41.2%) or 'somewhat clear' (9 participants, 52.9%), while only 1 (5.9%) said it was 'somewhat confusing'. None of the survey participants said the instructions were 'very confusing'.

Overall, our understanding is that the (written) instructions for Chaturaji are generally clear and easy-to-understand. However, there is still room for improvement, since when participants were asked to comment on them, three of them said that the explanations for how the pieces, especially 'special pieces' or 'horse and boat' could have been explained more clearly.

None of the participants provided comments on the video tutorial, as none of them chose to learn how the game is played by using that method.

All the above are questions that were posed for all seven tabletop games. As mentioned, for some of the games we asked a few additional questions. These are questions focusing on potential problems identified by us before talking with participants. For Chaturaji, we asked if the pieces' moves are easy to understand, and participants could rate this from 'very difficult' to 'very easy' on a scale from 1 to 5. None of them selected 1 or 2. Four participants (23.5%) selected 3, five participants (29.4%) selected 4, and eight (47.1%) participants selected 5.

The next question, also specific to Chaturaji, was 'Was it easy to find out how many points each piece was worth?', And participants were given a similar scale as the previous question, from 'very difficult' to 'very easy'. Again, none of them selected 1 or 2 and four participants (23.5%) selected 3. Three participants (17.6%) selected 4 and ten participants (58.8%) selected 5.

Finally, we posed one open-ended question so that participants could freely comment on each game. The question was posed as: 'Did you encounter any difficulties during gameplay? Please detail any issues (e.g., game unit colours, lighting, table size, chair comfort, noise levels, etc.).', with the subtitle: 'If you havent encountered any, you can simply answer 'No''. 13 out of 17 (76.5%) participants answered 'No'. One participant noted that it was hard to see the lines on the board because of the shadow created by the lighting above their head. Three participants commented that the numbers indicating how many points each piece is worth were printed backwards.

B.1.0.2 Mekuri

In the first question, 11 out of 36 participants said they have played Mekuri. This is a significantly lower number than those who have played Chaturaji and it is also the third lowest in general.

The ones who played were also less satisfied than the ones who played Chaturaji. Even though none of the 11 participants rated Mekuri 1 or 2 (out of 5) in terms of fun, seven of them rated 3 and the remaining four rated it 4/5. None of the participants awarded Mekuri a perfect score of 5/5. This means that Mekuri has an average of score of 3.36/5.

When they were asked to freely comment on what they liked or disliked about the game, 9 out of 11 did so. Five of them said that they thought the rules were too simple and that did not leave room for strategies or tactics that would make it more interesting. Two of them said that the rules were difficult to understand, but one said it was easy to understand. Finally, one person commented that they liked that you get different points for each type of cards.

When asked how many times they played Mekuri, the majority, seven people, said 'once' and the remaining four said they have played '2 or 3 times'. None of them said they have not finished the game and also none of them said they played more than three times.

Then we asked 'How much time did you spend on your first full playthrough of the game?'. The results were adequately satisfying, considering seven of them (63.6%) needed 5 to 20 minutes and only one person said that they needed more than 20 minutes. However, 3 people said they finished the game in less than 5 minutes, which we consider too fast as we would like people to engage more with Mekuri.

All the participants who played Mekuri said they learned the rules only by reading the instructions. They did not use the video tutorial or had anyone else explain to them.

Nine (81.8%) of them said they need less than 5 minutes to learn the rules and understand the game. Two said they needed 5 to 10 minutes, and no one said they needed more than 10 minutes.

None of the participants said that the instructions were 'very confusing'. Three participants (27.3%) said that they were 'somewhat confusing'. Five (45.5%) said

that they were 'somewhat clear' and three (27.3%) said that they 'very clear' and they understood everything with no issues.

Only one person provided additional comments on the instructions and they said there were no problems.

Even though, none of the participants learned the rules through the video tutorial, one of them commented that it was 'too short'. Our explanation is that this person tried to learn the rules by watching the video tutorial, but found it too short and then used another method (written instructions).

We also included two Mekuri-specific questions. The first one was: ' How easy was it to distinguish the colours on the cards?'. Participants could answer by providing a rating from 1 (very difficult) to 5 (very easy). It did not receive a single rating of 1, and only one rating of 2. Two participants rated it 3. Three participants rated it 4. And five participants rated it 5/5. Judging by the results, the design of the cards creates only a slight difficulty to distinguish the colours. However, it should be noted that this was not tested specifically with a group of people with visual disabilities.

The second question, unique only to Mekuri, was ' How easy was it to count your final scores in the game?'. Again, participants were given a scale from 1 (very difficult) to 5 (very easy). One participant said it was very difficult (1), zero participants granted a rating of 2, two participants awarded a rating of 3, two participants awarded it a rating of 4, and six awarded a rating of 5.

Again, the final question was the same as in all the other games: 'Did you encounter any difficulties during gameplay? Please detail any issues (e.g., game unit colours, lighting, table size, chair comfort, noise levels, etc.).', with the subtitle: 'If you havent encountered any, you can simply answer No. Seven participants said 'No'. One participant said that the they encountered difficulties with the rules. Another that it was difficult to distinguish between dark blue and black colours on the cards. Two participants reported encountering difficulties with the shape of the cards, specifically while holding, shuffling, or stacking them on top of one another.

B.1.0.3 Huuchuish

When asked if they have played Huuchuish at the exhibition, 16 participants (44.4%) replied that they have, and the remaining 20 (55.6%) that they have not. Regarding our sample of participants, Huuchuish was the third most played tabletop game, behind Shagai and Chaturaji.

Huuchuish received mixed rating when participants were asked to rate it in terms of fun. The results were the following:

- Three participants (18.8%) rated it 1/5.
- One participant (6.3%) rated it 2/5.
- Five participants (31.3%) rated it 3/5.
- Six participants (37.5%) rated it 4/5.

- One participant (6.3%) rated it 5/5.

That means that it received an average rating of 3.06/5, which means there is room for improvement.

When asked to write what they like or dislike about Huuchuish, eight individuals provided feedback. Three praised its simplicity and fun factor, highlighting how easy it was to learn and start playing. However, the majority (five out of eight) criticised the game for being too short in duration, too simple, or overly reliant on luck, with some citing a combination of these issues. These respondents felt that the game lacked strategic depth and that outcomes were largely random, with few opportunities to employ strategy.

One (6.3%) out of sixteen participants said they haven't finished the game. Nine of them (56.3%) said they have played the game once, while the remaining six (37.5%) said they have played 2 or 3 times. None of the participants said they have played more than 3 times.

When asked how much time they spent on their first full playthrough of the game, the majority (eleven out of sixteen) said they spent less than 5 minutes, while the remaining five spent between 5 and 20 minutes. None of the respondents spent more than 20 minutes. Based on this feedback, it is clear that the game's duration is quite short and could potentially be extended.

As with the other games, the majority (14 out of 16, 87.5%) learned the rules by reading the instructions. One respondent watched the video tutorial, and another mentioned that their son knew the rules (and possibly explained them).

The overwhelming majority (15 out of 16, 93.8%) reported that they needed less than 5 minutes to learn the rules and understand the game. Only one participant required between 5 and 10 minutes.

When asked to rate the clarity of the instructions, 14 out of the 15 individuals who used this method found them to be 'very clear,' while one person found them 'somewhat clear.' This, combined with the brief time required to understand the game, validates their previous responses that the game is simple, and, according to some, too simple.

When asked to comment on the instructions, only one person did so, writing that there was no problem.

When asked if they want to provide any positive or negative feedback on the video tutorial, one person commented 'Positive' while another replied but said they had no feedback.

When asked if they wished to provide any positive or negative feedback on the video tutorial, one person commented 'Positive,' while another responded but stated they had no feedback.

All sixteen participants granted a rating of 5/5 for the ease of counting their final scores, which is a Huuchuish-specific question.

In the final question: 'Did you encounter any difficulties during gameplay? Please detail any issues (e.g., game unit colours, lighting, table size, chair comfort, noise levels, etc.).') with the subtitle: 'If you havent encountered any, you can simply answer 'No.", 15 out of 16 people replied 'No'. One of them commented that a walnut was missing, which may have been a temporary issue at the time they played the game.

B.1.0.4 Ganjifa

Out of 36 participants, only 10 (27.8%) replied that they have played Ganjifa.

Ganjifa received mixed ratings when participants were asked to rate it in terms of fun. The average score was 3.2/5 and no participant rated it 5/5.

When prompted to share their opinions on the game, two people commented. One said that it is better when there are more than two players. The second one acknowledged the game's potential but suggested that it could be further improved by placing greater emphasis on strategic gameplay.

Seven of the participants played Ganjifa once, while three played 2 or 3 times.

When asked how much time they spent on their first full playthrough of the game, two participants said they needed less than 5 minutes, while the majority (8/10) said they needed 5 to 20 minutes.

All of the participants learnt the rules by reading the instructions.

Nearly all of the participants (9/10) said that they spent less than 5 minutes reading the rules and understanding the game. One participant said they spent 5 to 10 minutes.

While no participant said that the instructions were 'very confusing', one said that they were 'somewhat confusing', six said that they were 'somewhat clear'. Three participants encountered virtually no issues with the instructions, characterising them as 'very clear'.

However, when prompted to openly comment on the instructions, two people did and said that they were very clear and they met no problems. This probably indicates that they were two of the three who selected 'very clear' in the previous question.

None of the participants said they encountered any difficulties while playing the game.

B.1.0.5 Weiqi/Go

Out of 36 participants, 13 (36.1%) replied that they have played Weiqi.

Weiqi received an average rating of 3.9/5, with no participants rating it 1 or 2 out of 5.

When asked to openly comment what they like or dislike about Weiqi, three participants replied. One said that they did not like their dad won all the time, another

that it is pretty easy and fast even though they are inexperienced. And another that they liked Weiqi because they like games with strategy or logic elements.

Most of those who played, nine out of thirteen (69.2%), replied that they played the game once. One said they played twice, while two said they played 3 or more times. One participant however said they did not finish the game.

Seven participants needed less than 5 minutes for their first playthrough of the game, while six participants needed 5 to 20 minutes. None of them needed more than 20 minutes. This can be explained by the fact that this is a shorter and simplified version of Weiqi/Go, called Atari-Go.

Weiqi is the game that is most popular and commonly found outside the museum too. As a result, it was expected that it was the game that most participants knew its rules already from somewhere else. Five out of eleven did so which is 38.5% of our sample. Seven people read the instructions and one both read the instructions and watched the video tutorial.

Ten people said they spent less than 5 minutes learning the rules and understanding the game, while one said they spent 5 to 10 minutes.

When asked to rate the clarity of the instructions, four people said they understood everything with no issues, while another four that they understood most of the instructions but some parts could be clearer. Two people were confused by some parts.

When asked to comment on the instructions, one person said it was a little difficult to understand some parts. Another was more specific, saying that it was difficult to understand when an opponent's pieces were surrounded.

Eight of the participants said they noticed they played a simplified variant of Weiqi/Go, while the remaining five did not.

Only one participant said they encountered difficulties, and again it had to do with the clarity of the instructions regarding surrounding the opponent's pieces.

B.1.0.6 Shagai

Out of 36 participants, 21 said they have played Shagai at the exhibition. This is considered a rather high percentage and makes Shagai the most played of the seven board games.

Shagai received rather positive ratings from the participants. Only one of them rated it 1/5 and none 2/5. The average rating was 3.95/5.

Eight of the participants also commented on what they liked or disliked about Shagai. The majority found the game fun and appreciated its ease of learning and play. However, some noted that mastering the game presented a challenge. A few participants struggled to distinguish between the four sides of the game pieces. Additionally, some suggested that the flicking technique could be more clearly explained.

Two participants did not complete the game. Nine played once, eight played 2-3 times, and two played more than three times. The fact that most participants played multiple times suggests that Shagai was quite engaging.

Approximately one-third of participants spent under five minutes on their initial playthrough of the game, while the remaining two-thirds spent for 5 to 20 minutes. No participant reported playing for more than 20 minutes.

Nearly all participants (18) stated that they learned how to play by reading the instructions. Two participants mentioned that someone explained the game to them, while one indicated they already knew how to play from somewhere else.

The vast majority of participants spent less than five minutes learning the rules and understanding the game. Only two required 5 to 10 minutes, and none needed more than 10. This validates their earlier feedback that the game was easy to learn.

Out of twenty participants that rated the clarity of the written instructions, half of them said it was very clear. Nine of them said it was somewhat clear, and only one that it was somewhat confusing.

When asked to comment on the instructions, one participant suggested that the guidance on flicking the pieces could have been clearer, while two others commented on the names and appearance of each side of the pieces. They felt that learning the names was unnecessary and added an avoidable cognitive load.

When asked to share their thoughts on the pieces being painted in different colours, nine participants said it looked good, eight found it confusing, and five felt it made no difference. One participant noted that while the colours added visual variety, they might also contribute to some confusion.

When asked if they encountered any difficulties during gameplay, 11 participants said 'No', while others reported various issues. Four participants mentioned having trouble differentiating the sides of the pieces, and one reported sore fingers after flicking. Another participant was confused about whether the colours mattered, and one was unsure about how to flick the pieces. One participant noted that for someone with smaller hands, holding all the pieces at the start could be challenging. Other issues included pieces falling off the table and uncertainty about whether they could continue playing or if it was the other player's turn after making the pieces touch.

B.1.0.7 Senet

Senet was the least played game among the seven in the exhibition, with only five participants (13.9%) reporting that they have played it.

Even though the sample is rather small, its ratings were positive, with an average of 4/5.

When asked what they liked and/or disliked about the game, one participant simply stated, 'I won.' Another noted that while the game was somewhat luck-based, it was still fun, and there was room for some strategy. A third participant appreciated

the possibility of strategising without the game being overly complicated, as well as the ability to make it more difficult for their opponent. They also found the dice interesting, though they mentioned it was initially confusing to determine the number of steps one must move, which required some practice.

Three participants said they played once, while two played 2 or 3 times.

All five participants reported spending 5 to 20 minutes on their first playthrough of the game.

Additionally, they all learned how to play by reading the written instructions.

All five spent less than five minutes to learn the rules and understand the game.

Four participants found the instructions very clear and had no issues understanding everything. One participant, however, felt the instructions were somewhat confusing, and they understood most of them, some parts could have been clearer.

Two participants also commented on the written instructions, and both agreed that they were clear.

None of the five participants who played Senet reported encountering any difficulties during gameplay.