

# Final Report

## ART2D2

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# Chapter 1- Introduction and Background

The purpose of this chapter is to provide an overview of the research that was conducted in order to address the lack of personalized information while touring an art museum. The problem revolves around the domain of culture, focusing on providing information to visitors. After the research, the team was able to understand the problem, its significance and its actual context. Part of the process was gaining insight into the problem and relevant stakeholders by conducting a literature review. This chapter starts with a presentation of the identified problem and explains its importance, after this, it outlines the target population. Finally, this chapter observes the current solutions to this problem and the limitations they come with, to facilitate the creation of better approaches in the following chapters.

## 1.1 Identified problem

The identified problem is the lack of personalized experiences in museums, whether through traditional tour guides or standardized audio guides, it fails to cater to the diverse interests and learning preferences of individual visitors. This limitation leads to reduced engagement and visitor satisfaction highlighting the need for adaptive and personalized visitor-support systems. (Wu *et al*, 2023 and Pechenizkiy, 2007)

The traditional museum experience revolves around a generic formula for all exhibits(Fogli & Arenghi, 2018), which does not help in providing a versatile experience for the visitors. Generalised information, combined with static exhibits can lead to failure when it comes to satisfying the interests of visitors. Moreover, studies made on visitors, show that “that learning is stimulated when the information is described in terms that the visitor can understand and if it makes reference to their interests as well as concepts that the visitor has already encountered during the navigation/visit” (Bowen, J., & Filippini-Fantoni, S.,2004).

Unlike other activities, most people do not visit the same museum multiple times, since the exhibitions rarely change. This means that the quicker this problem is solved, the more people will have better experiences when visiting the museum they are likely to not see again. Additionally, there are people with learning disabilities who have a harder time following along with a guided group at the same pace, so implementing an alternative would be very helpful for them, so they could also enjoy the additional facts that come with a guide.

## 1.2 Identified target population

The issue of personalization in museums came naturally, additionally backed by research, because everyone in the team either experienced or knew someone who has experienced these issues. In order to put a list together, we had a brainstorming session where we talked about who we think is the most affected by this issue and why. Then we narrowed it down and/or combined some of them into a concise list.

The reasons these specific Stakeholders (the people affected by this issue) are part of the list are explained below:

### 1.2.1 Stakeholders

Direct Stakeholders:

1. **Museum visitors who dislike large groups:** The main way of getting a more tailored museum experience is getting a guided tour. This however implies having to go with a larger group of people, which not everyone is comfortable with for various reasons. (anxiety, disability, illness or simply wanting to go at their own pace)
2. **Parents with kids who might ask a lot of questions:** Some people who visit expositions, accompanied by their kids, have a hard time following the normal pace of a tour because they have to answer their kid's questions. Making the experience of following a guided tour a hard task.
3. **Students who want to deepen their knowledge of a subject:** Besides enriching their culture, many students visit museums to get a better grasp of a subject in their academic curriculum.
4. **Tech geeks who are interested in technology:** People who are passionate about technologies that grant a more immersive experience take a keen interest in how museums upgrade their touring experience with such technologies.
5. **People who are specifically interested in a certain topic:** By this we mean people who go to museums to learn more about a very specific thing, such as an instance from a painter's life or a specific historic event.

Indirect Stakeholders:

1. **Museum owners (Public or private):** Obviously, since we are trying to implement one of these solutions in museums, it will impact the attendance of that museum, which directly impacts the museum owner.
2. **Exhibit Creators/Organizers:** Whenever an exhibit changes, we will count on exhibit creators to help supply us with relevant and factually correct information to update our system.
3. **Agencies promoting/reviewing exhibits:** Whenever an innovative technology appears, especially one that would be publicly available, media outlets will talk about it.

## 1.2.2 Problem scenarios

After discussing the various stakeholders involved, now we introduce the problem scenarios that describe the situation before we implement any of our concept solutions and how the specific stakeholder relates to the personalization problem.

· **Museum visitors who dislike large groups:** Christina, a 28 year old introvert with social anxiety, prefers to explore museum exhibits independently to avoid the large crowds typically associated with guided tours. However, she finds it difficult to access insights about the exhibits on her own that interest her. The information on the plaques feels generic and limited, making it hard for her to engage deeply or connect the exhibits to her own interests and curiosity.

Personalized systems would relieve her of the stress of group tours and would allow her to explore in peace.

· **Parents with kids:** Marco, a 35 year old father is visiting the museum with his children, who quickly lose interest in the exhibits and become restless. The lack of engaging or adaptable content makes it difficult for Marco to maintain their attention. He feels frustrated as he struggles to make the experience enjoyable for them while also gaining meaningful insights from the visit himself. A personalized system would allow Marco to enjoy his visit, while his kids are entertained by interactive child friendly content.

· **Students:** Nick who is a 22 year old University student wants to deepen his knowledge on art history and visual cultures. However, the museum only offers a surface-level description which forces him to look up information online. A tailored system could provide academic insight to enhance the level of detail of Nick's learning experience.

· **Tech Enthusiasts:** Luciano, a 30 year old, electronic engineer and a tech enthusiast is drawn to the museum due to the advertising of interactive digital displays. However, he finds most classical tours boring and also feels that tour guides move too fast. He has also experienced complex or poorly designed technologies in museums which leaves him frustrated. A well done implemented solution would provide satisfaction for his passion of cutting edge technology, while enhancing his museum experience.

· **Topic Specific Visitors:** James, a Napoleonic military enthusiast, wants to understand the influence of the technologies that were introduced during that time and the strategies that were deployed on the art of warfare. There is a lot of content in the museum but none of which is tailored to his specific interest which disappoints him. Even the places where the information provided does meet his interests, on most occasions he has to go through lots of other irrelevant information which does not interest him. A personalized system could tailor content to better match his interests.

**·Exhibit Creators/Organizers:** The Exhibit Organizers like Lando, are facing challenges in designing content that caters to the diverse needs of visitors. They have to maintain a balance of interactivity and attention to detail. This also proves challenging due to time and money constraints. **The addition of a personalized system could increase visitor satisfaction and attendance.**

**·Tourism Agencies promoting the museums:** Tourism agencies promoting the exhibition struggle to give answers to the criticisms of the groups of people of state that the museum experience does not meet their expectations which makes it harder for them to promote the museum. **The addition of the personalized systems in museums would improve the overall touring experience of visitors, making it easier for media entities to promote museums and address criticism about generic experiences.**

**·Media and Press Promoting/Reviewing the Exhibits:** Media outlets that cover the museum make note of the lack of personalization that affects the perception of the visitors. They also show an insufficient amount of information about the exhibits.

To summarize, the museum's current approach to exhibits often results in a one-size-fits-all experience leaving the stakeholders unsatisfied. The direct stakeholders, like visitors, struggle with unmet expectations whether it is more in-depth content, personalized guidance or engaging and interactive technology. Indirect stakeholders like Exhibit Creators and tourism agencies face the effects of the challenges mentioned above such as negative feedback.

### 1.3 State of the art

Currently, there are several solutions that are used to solve this problem. Firstly, as stated by Char, M. (2024), interactive Augmented Reality (AR) is utilized in several museums. Furthermore, several museums also use customizable virtual reality to enhance visitor experience (Shehade and Lambert, 2020). Additionally, according to Dressel (2024), there are also museums that utilize motion tracking technology that allows exhibits to respond to users dynamically. In conjunction to this, some museums also have a gamified experience that includes learning challenges and treasure hunts to engage and motivate visitors. (Dressel, 2024)

According to Marques and Costello (2018), a major problem with the use of AR technology is that it disconnects the users from the actual museum pieces and causes them to focus more on the AR technology.

Moving on to the use of motion tracking technology, there are several concerns regarding the gestures which must be simple enough for the visitors. Another concern with this is the precision of sensors and the output images which involve users sometimes experiencing hand track loss and miss targets during interaction. (Ma, 2021)

As stated by Madsen (2020), a major problem with the gamification of the museum experience is that there is no evidence to suggest that there is a lack of evidence to suggest that gamification improves the engagement of visitors. Another problem is the limited attention span of visitors which might cause them to be overwhelmed by excess information or stimuli. (Ćosović and Brkić, 2020)

# Chapter 2 - Proposed Concepts

This chapter presents the concepts that aim to address the lack of personalized information in museums. After rounds of brainstorming and iterative design processes, multiple solutions were refined. Each concept will be presented detailing what kind of intelligence it uses, how it works, in what way it fits the needs of the stakeholders, and how it compares to existing solutions. In addition, scenarios and storyboards are included to offer a better idea on how these solutions will be used by the stakeholders in real world situations.

## 2.1 LLM-powered tour guide.

The solution uses off-the-shelf intelligence to enable the interactions.

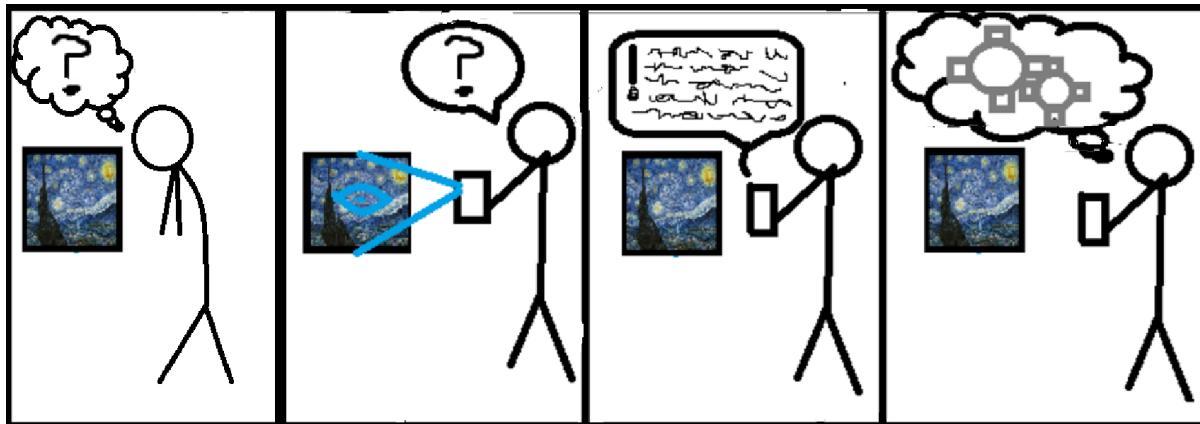
This solution implements a conversational AI model that acts as a tour guide. Visitors can interact with it through an app. The interaction would start with a visitor scanning the art piece. Then the model identifies which painting it is, and provides a brief overview, after which a visitor can enter their requests, questions can be broad, or very specific, depending on what the visitor is interested in.

This solution offers a personalized visit, which definitely improves the experience for groups like students or researchers, or art and history enthusiasts. By responding to specific requests, it provides in-depth information that is tailored to visitors' interests, creating a more engaging experience.

Another problem specific to tech-passionate people stakeholders is the lack of information about the technology behind our LLM-powered guide. One way of solving this and also enhancing the concept is by adding a "how does it work" button in the menu of the app. Once pressed the user will be prompted to chat with the AI and be questioned "What do you want to know?". Now the AI can answer questions regarding the data set it was trained on, how the scanning of the exhibits works and the vision models it uses. The team believes that this modification will bring satisfaction to people interested in the technology used in museums to enhance the experience, an important part of our stakeholders.

In museums, you can usually access the recorded tour guides or read some information on the plaques next to the paintings, or museums offer LLM-based solutions, however, remotely. This solution would be used in the museum itself, so it would enable a higher level of interactivity and personalization.

To get a better understanding of how the concept would be used in practice, a scenario has been written (check [Appendix2, Scenario LLM powered tour guide](#)). In the scenario, a visitor interacts with the LLM powered model and does different things like scanning artworks, exploring the technical details of the model and receiving information.



Visitor has a question  
About a painting

They ask the question  
Curated info answers

An LLM who has extra  
Curated info answers

The visitor is motivated  
To think

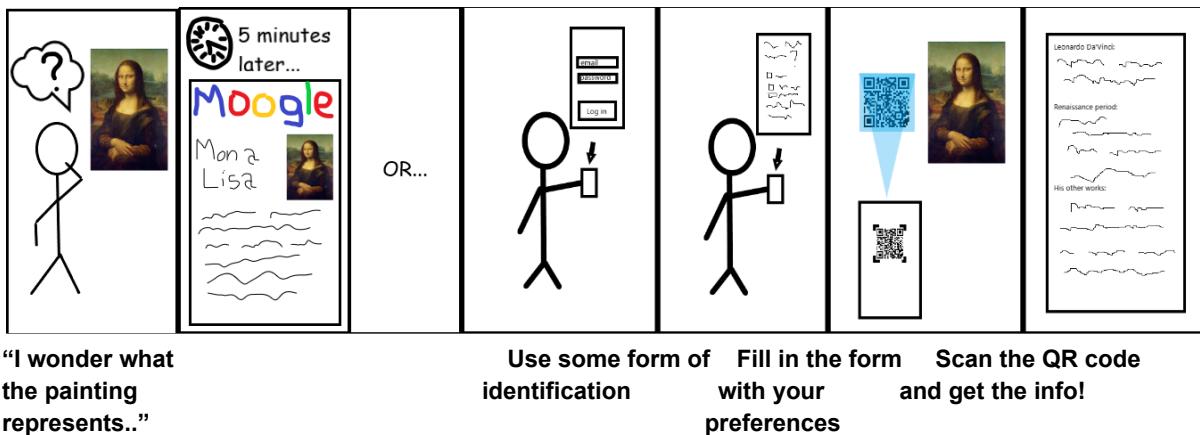
## 2.2 Scannable codes beside each artwork that provide additional personalised context

The solution does not correspond entirely to an “off-the-shelf” intelligence, but an innovative approach that combines user interfaces and adaptive machine learning. The way the solution works is by placing a QR code next to every exhibit of the museum. Before visitors start touring, they are invited to make an account on a website/app. When creating the profile, the guest needs to answer questions that will help gauge his interests and preferences, thanks to machine learning algorithms. When scanning the QR code, the visitors will be met with information regarding the exhibit in a tailored manner, accommodating their language and complexity of terms, presenting more or less information based on how much they prefer the certain category that the exhibit is part of.

This solution aims to prevent information overload by offering personalized experiences and making sure visitors receive content they can understand and enjoy. Moreover, the visitor has the freedom to explore what he wants at his own pace, with every piece of content evolving based on the previously viewed exhibits. Even more, this approach helps a lot of the target subgroups, by reducing the costs, because there is no tour guide.

Many museums already offer QR codes or audio systems, but this solution stands out due to its use of adaptive personalization. The system offers automatically tailored content in a dynamic way, evolving with the user journey, different from normal guides. This aligns with the findings of Solima and Izzo (2020), who think that QR codes have great potential to enhance the touring experience. Furthermore, the continuous feedback system ensures real-time refinement of the content ensuring immersion, relevance and engagement of the visitors.

In order to get more insight on how this solution works, a developed scenario can be read([check Appendix](#)). In the scenario, a visitor explores a museum using the QR web app.



## 2.3 Recorded AR tour guide

The solution uses a novel interface modality, augmented reality.

For this solution, visitors would use AR-enabled devices to view recorded guides. This solution would work in a way that a visitor is wearing augmented reality glasses, that provide pre-recorded additional information about exhibits, such as more history information or visual cues for the details that are often overlooked. Another aspect is the enhancement of the experience, through the use of 3D models, for example, the visitor has the option to see an accurate virtual depiction of the original version of the exhibit because time might alter the way it looks.

This solution offers more benefits for subgroups such as students, and art enthusiasts, by providing information in a more digestible way. This concept provides a more multidimensional experience that is not achievable with usual approaches (audio or text guides). Moreover, the solution offers visitors the option to customise their experience by choosing a figure relevant to the exposition as their guide.

One problem regarding the concept is the maintenance (charging, sanitization) and limited availability during peak hours of the AR devices. One solution is to implement self-management kiosks, where visitors can pick up and return the AR glasses. Another one is to implement a booking system that allows visitors to reserve in advance, reducing wait times.

Another problem is that the interaction mode is not clearly defined, so an introductory tutorial at the start of the tour should teach the visitors how to use the glasses properly. Navigation can constitute a challenge when using the headset, since the system uses the visitor's location to identify exhibits, so integration of computer vision technology aids in making the AR recognize exhibits accurately.

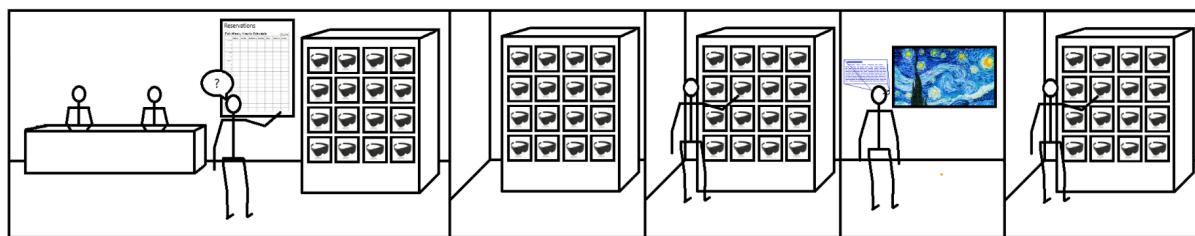
Moreover, one problem is the difficulty in balancing engagement across ages, since the content might not be easy to digest for younger audiences. Our solution to this is to implement a family mode with age-appropriate content. Young kids would get simplified content and more

animations and games like scavenger hunts and trivia. Teens get detailed explanations with interactive 3D visualizations and adults get standard AR content, focused on deeper learning.

What distinguishes this concept from existing solutions, is the visualisation of the artificial tour guide, making the experience more enjoyable and immersive.

To illustrate the process of using this solution, a scenario has been written ([check appendix](#)). The scenario highlights how a user interacts with the AR tour guide, from picking up the glasses to using them to explore the museum. Moreover, a storyboard shows the key interactions that a user has.

AR glasses kiosk   Person grabs a pair      Experience enhanced tour      Return the glasses



## 2.4 Form for Personalized Routes

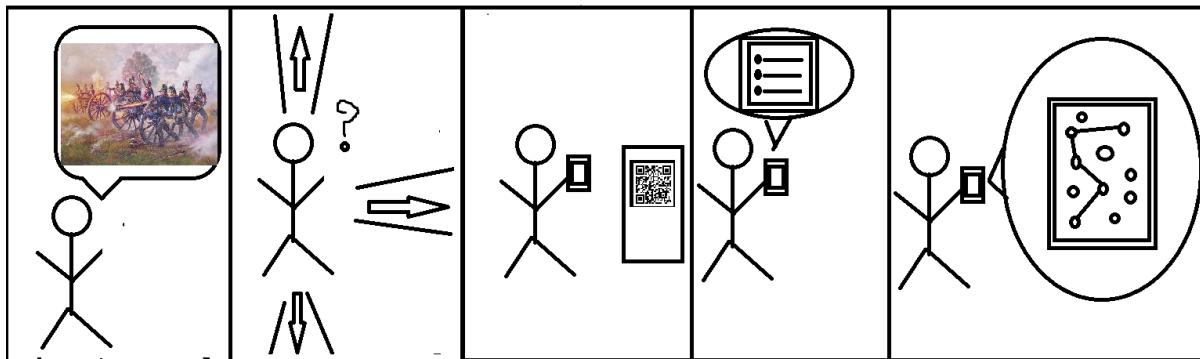
The solution uses a novel interface modality (technology).

Visitors begin their tailored experience in the museum by scanning a QR code that prompts them to a webpage , where they are going to complete a form. The form gathers information regarding their interests, time constraints, mobility etc. The AI model then processes this data and gives a specific route for them to follow. The route is shown on the website or a smartphone app highlighting each of the visitor's preferences.

The solution caters to diverse visitors' needs by providing personalized experiences. It helps enthusiasts focus on their areas of interest and maximizes time for those on tight schedules. Tailoring the museum journey enhances satisfaction and engagement from visitors, making their tour more enjoyable.

Traditional tours follow a fixed route and pace which might not align with the preferences of all visitors. Even tours with different routes are not specific enough for the specific needs of every visitor.

In order to grasp the concept better, a scenario is made available [in the appendix](#), followed by a graphical representation in the form of a storyboard.



Person scans a QR code

Completes a form

A route is prepared

## 2.5 LLM compares two paintings

The solution utilizes off-the-shelf intelligence to enable the interactions.

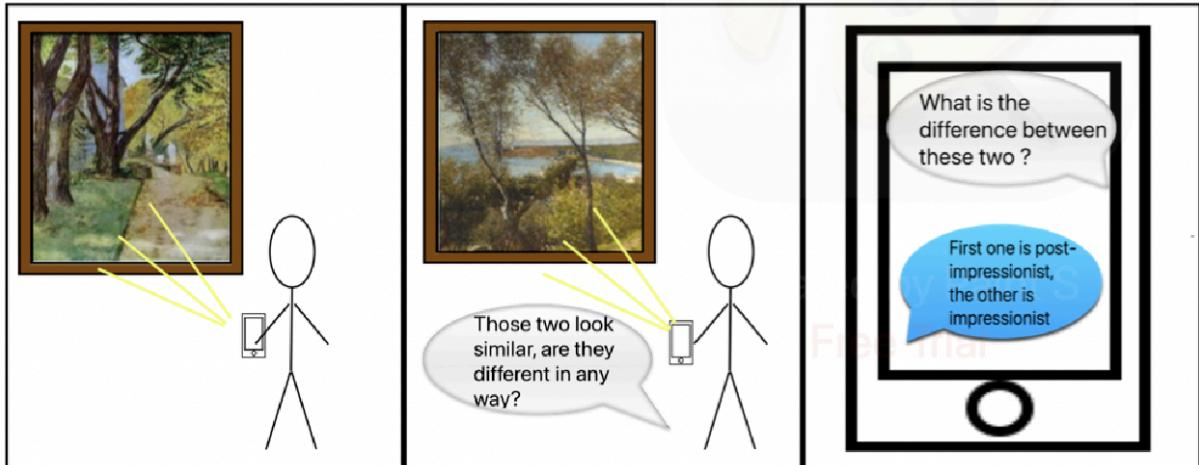
In this solution, the user can choose two paintings to compare, which is going to be done with an LLM model, which will compare the curated information of both artworks, and highlights the differences (or in cases of a popular comparison, a human authored comparison is provided). The user will get back a comparison of two paintings, for example, they both portray the same historical event, however, one is more focused on the emotional impact while the other focuses on the realism and gravitas of the action.

This allows for a more personalized experience in the museum, as visitors can choose for themselves what they want to compare and find out new facts about both of the paintings, but in relative perspective.

By implementing this technology, museums can offer dynamic and engaging experiences that cater to individual interests. Visitors can compare paintings based on different criterias, such as: themes, styles, artists, or even periods, which helps to learn information more easily.

The LLM model can present these insights in an accessible manner by making complex artistic concepts easier to grasp. This concept not only improves learning opportunities but encourages deeper exploration of museum collections as well. It creates an environment where visitors are active participants, sparking curiosity and fostering a meaningful connection with the artworks. This modernizes the museum experience while respecting the timeless value of art.

A scenario describing the process of interacting with the concept can be found in the [appendix](#). Moreover there is also a story board that offers a visual representation of the process.



Takes a photo of a painting

Takes a photo of another

The model compares

# Chapter 3 - User Confrontation

In this chapter, we present the findings from user interviews conducted in order to better understand the problem of lack of personalization in museums, the context in which it operates and the impression that users have towards different solutions to the afore-mentioned problem. The interviews aimed to gather insights from stakeholders to refine and select the best concept for addressing the lack of personalization in museums. By engaging with users, we sought to identify their preferences, challenges and expectations regarding museum experiences, particularly regarding technology and personalization.

## 3.1 Interview plan

In this chapter we present research questions and a list of sub research questions that need to be answered following the interview. Then, looking at the sub-research questions we create appropriate interview questions to ask relevant users in order to collect data to form a conclusion to select the best concept.

**Research Questions:** What is the best way to solve the problem of the lack of personalization in museums (as stated by (Wu et al, 2023 and Pechenizkiy, 2007)):

**Sub Research Questions:**

- What are the types of content formats (audio, text, visual, AR/VR)?
- How do personalized routes compare with traditional routes in terms of visitor satisfaction?
- How do different demographics (age, interests etc) affect the personalization needs?
- How can visitors specify their interests without increasing inconvenience or complexity?
- What are the challenges that museums face in their current setups with regards to personalization?
- How do visitors respond to different personalization concepts (for example, LLM powered guides vs AR experiences)
- What factors influence the ease of the use of technologies such as QR scanning, AR/VR etc.
- Are typical museum visitors accustomed to using these types of technology during tours?

- What role do visitors' interests or prior knowledge play in shaping their expectations of personalization?
- What are visitors' expectations regarding the balance between interactivity and simplicity in technology-enabled personalization?

**Interview Questions:**

1. When getting additional information in a museum, what form of communication do you prefer (audio, text, video, etc.)?
2. Are you willing to download the museum's app to get additional services?
3. Would you be willing to make an account to access museum facilities?
4. Have you ever utilized technology in a museum? If so, which one? Did you like it?
5. How would you evaluate current technological features in museums?
6. Have you ever utilized AR? If so, what is your opinion on it?
7. (ONLY FOR PARENTS) What challenges do you face in keeping kids entertained in a museum?
8. (ONLY FOR PARENTS) Would an interactive environment designed for kids help you? If so, how?
9. What is the biggest disadvantage for you in visiting museums?
10. Do you prefer group guided tours? Why?
11. Have you experienced any personalized features in a museum?
12. Can you think of a time that a particular format (AR/audio tour) enhanced or detracted from your visit and why?
13. If you could customize your own route, what factors would be most important to you (e.g., time, interests, difficulty)?
14. If a museum were to ask you about your interests before a visit, how would you like to provide this information (e.g., app, questionnaire)?
15. Do you prefer museum technologies to be highly interactive or simple and straightforward? Why?
16. What concerns do you have about overly interactive or overly simple personalization tools?
17. To what extent do you think technology should be used in museums so that it does not detract or distract you from the actual museum exhibits?
18. What do you think of gaining specific information from museum pieces based on what you ask
19. How would you feel about using a personalized route generated specifically for you?
20. Do you think you would benefit from personalized content in a museum?

**Research Question:** What is the main reason that people go to art museums?

**Sub Research Questions**

- Do people want to learn while at the museum?
- Do people find the usual text plaques next to paintings enough?
- If not, how difficult is it for people to access information on their own?

**Interview Questions:**

21. Do you like art museums and exhibitions?
22. What is your goal for visiting the museum (e.g learn, only look at art pieces, get some background information, etc.)?
23. Do you prefer to get in-depth information from the museum exhibitions?
24. How easy is it to get the desired information (in-depth one) about an art piece? Which tools do you utilize?
25. When You Visit a museum, and you want to learn more about an exhibit, what do you do?

**Correlation between Research and Interview Questions**

Below the correlation between the interview questions and the research questions are given in order to better explain our choice of interview questions.

**Questions 1-3: Content Formats and Technology Preferences:**

**Correlation:** These questions explore visitors' preferences for content formats and their willingness to engage with technology, which directly relates to understanding how personalization can be implemented effectively.

**Questions 4-6: Experience with Technology:**

**Correlation:** These questions assess visitors' experiences with existing technologies, providing insights into what works well and what does not, which is crucial for designing personalized solutions.

**Questions 7-8: Personalization for Specific Demographics (Parents):**

**Correlation:** These questions focus on the personalization needs of specific demographics (parents with children), which is a key aspect of RQ1.

**Questions 9-12: Challenges and Preferences in Museum Visits:**

**Correlation:** These questions identify challenges visitors face and their preferences for personalization, helping to address RQ1 by understanding what improvements are needed.

**Questions 13-16: Customization and Interest Specification:**

**Correlation:** These questions explore how visitors would like to specify their interests and customize their experiences, which is central to solving the lack of personalization.

**Questions 17-20: Technology Use and Personalization Expectations:**

**Correlation:** These questions assess visitors' expectations and concerns regarding technology-enabled personalization, directly addressing RQ1.

**Questions 21-22: Goals for Visiting Museums:**

**Correlation:** These questions explore the primary reasons visitors go to museums, which directly relates to RQ2.

**Questions 23-24: Accessing Information:**

**Correlation:** These questions assess how visitors access information and their preferences for learning, which ties into the reasons they visit museums.

**Question 25: Learning Behavior:**

**Correlation:** This question provides insights into visitors' learning behaviors, further addressing RQ2 by understanding how they engage with museum content.

### **Interview Methodology**

The interviews allowed participants to express their opinions through a structured yet conversational format. The interview rounds included six participants, carefully selected to represent a diverse range of demographics and ensure a variety of perspectives. Among the participants were a tech-savvy male in his 20s with a keen interest in exploring new technologies, two individuals who expressed a dislike for large crowds (two males in their 20s), a young male student in his 20s passionate about deepening his knowledge of the arts, a mother in her 40s with young children, and a woman in her 20s with a strong interest in a specific topic. There were no proxy users that were used in this assignment.

The goal of these interviews is to gather information from stakeholders and gauge how useful each of our 5 solutions would be for these stakeholders. To try and remove bias, we decided to not directly ask them about ideas, and instead about most related factors to get a better impression of what stakeholders experience and which their main gripes are with the current system. Then we can choose the solution, or adapt a solution to fit closely to what a stakeholder wants.

**Setup:**

The interviews were conducted in quiet rooms in order to ensure privacy and minimal distractions. The interviews were recorded only with the participant's consent.

**Protocol:**

After a brief introduction to the goals of our project, request verbal/written consent for participation and recording. Next, collect demographic information(age, occupation, familiarity with museums and technology), but anonymise the data to reduce the risk of private data exposure. One individual starts asking the interview questions, that are provided below, while another takes notes. After the questions are finished. The interviewer presents the concepts and provides storyboards pointing out what does and does not align with the participant's responses, so more potential issues with the concept can arise and the concepts can be refined to be more user-centered. Now request an initial impression by observing their facial reaction and levels of interest they seem to have by their responses and take notes regarding these impressions, concerns and advantages of showcased solutions. For the final part of the interview, summarize the key points of the interview and present them to the participant, which ensures that the data was collected accurately from the interviewee point of view as well. Make sure that the recorded data resembles as much as possible the interviewee's opinion. Thank the participant for their time and input.

**Data Handling:**

In the introduction of the interview, during the consent process, all collected data will be stored safely on secure, password-protected systems, accessible only to the team. Moreover, the participant is presented with a list of possessed rights: right to access (participants can request and review data collected about them), right to rectification (can correct inaccuracies if requested), right to be forgotten (delete their data upon request), right to restrict processing (pause processing of their data if concern is raised) and right to data portability (provide a copy of their data in a requested format).

The participant is also informed that after the project conclusion, any data that regards them is permanently deleted.

## 3.2 Results

The participants were interviewed, and in most cases the recordings were made (when there was no permission to record, the transcriptions were made during the interview). After the answers were recorded, the audio files were transcribed. Next step that was taken- is familiarizing the team with the data. That allowed us to identify initial thoughts and patterns, as well as create a few comments about the data collected. After that the data was divided into smaller pieces, where interview questions themselves created a good basis for the division on different topics/answers for the research questions, as for example, the question "How easy is it to get the desired information (in-depth one) about an art piece? Which tools do you utilize?" allows you to get the information about the ease of accessing information, challenges with current tools, or the use of labels, guides, apps. Those pieces were grouped into broader categories that were combined to get the themes.

### 3.2.1 Thematic analysis

To analyze the data we used thematic analysis. Initially, we grouped together common answers from different interviewees based on the different questions being asked. The most common answers (more than 3 out of 6) were then grouped into broader categories which then further developed into themes. For example, the theme "Technology should be accessible" was developed from multiple participants expressing frustrations with overly complex technological implementations.

#### **Theme 1: Technology should be accessible**

Participants consistently expressed that while technology has potential benefits for the experience, it should not burden the users with a lot of steps to take to utilize it. Participants had a similar direction of opinions (that the utilization should not be complicated and irritating), however, the degree to which the technological features are valued differed. For example, 5 participants out of 6 express strong negative opinion towards the technological implementation : "Absolutely not, usually whatever a museum provides with an app is not worth the 10 seconds it takes to download the app", "Absolutely not, I do not wish to add any more accounts to the pile"

While technology can be beneficial, an excess of it, particularly when it becomes intrusive, can diminish the museum experience. Although it's important to provide access to additional information, it should be done in a way that is effortless for the visitor and does not require them to share personal information.

#### **Theme 2: Independence**

Users prefer to go their own way rather than following some personalized routes. Users also value not being attached to a group that causes them to move slower or faster than they desire. One participant remarked, "Usually just inside a museum I can just go at my own pace so if I want to go faster or slower, I can just do that." Another strongly opposed predefined paths, stating, "I don't like routes, I don't like plans, and I definitely don't like any kind of personalized route." Some participants appreciated tour guides for providing insightful information, however, they still would like to have their own pace for exploring art pieces. (QUOTE)

"Usually just inside a museum I can just go on my own pace so if I want to go faster or slower I can just do that"

"I don't like routes, I don't like plans, and I definitely don't like any kind of personalised route"

"Guided tours I am not a big fan of, I have my own pace."

"I don't think I would ever think about such things, I mostly wander around aimlessly and observe and learn. I would never build a route in advance."

There were also users who were interested in the idea:

"Sure, sounds interesting"

" I'd like to get the shortest path based on my interest"

And also a more nuanced opinion like:

"I think it's very cool, but this can result still in overcrowding if you have common tastes"

In total 3 out of the 6 interviewees were supportive of the idea of guided tours as they liked the idea of visiting artworks of a type that they wish to see, while the other 3 were hesitant or rejected it outright preferring to go at their own pace.

### **Theme 3: Interaction vs distraction**

Users tend to like technology in so far as it supports what they want. However in a museum, art or history is the reason people visit. Any technological solution should aim to not distract from the art itself. Every single one of the users expressed that overly interactive features risk becoming a distraction rather than an interaction. For example, "The overly interactive can steal the attention from the art.", "Overly interactive can be too distracting- overly simple can be boring.". The technology should be a complimentary element, so it is carefully implemented into the museum experience rather than distracting from the goals of visit. "I think technology should be used in museums so that it does not detract or distract you from the actual museum exhibits". While interactivity can enhance the museum experience, the concept should ensure that it supports the user's goals without overshadowing the exhibits or disrupting their visit.

### **3.3 Reflection and iteration**

The interview results highlighted the problems in the design. The following alterations to the concepts are necessary to ensure an adequate experience for the stakeholders. First of all, a

common problem among stakeholders is mandatory app download and account creation. A simple solution to this is to use a QR code that prompts the user to a webpage to avoid the need for an app or an account. Most of the interviewees viewed these as unnecessary complexities. A web platform aligns better with the simplicity and accessibility our users expect.

Second, users who had experience with AR/VR found it distracting. Participants expressed a preference for text or video and they perceived them to align better in the goals of getting information without being overwhelming and distracting from the exhibits. The team chose to focus on text, video or LLM-type content, and use AR/VR only for special exhibits. Furthermore, another piece of information gained from the interviews is the mixed opinions of rigidly planned routes and the preference to wander at their own pace. One alteration that can help in ensuring this for the users is to offer routes that aren't rigidly planned, but still offer a clear chronological path as stated by an interviewee, so they are free to explore at their own pace and still get an educative experience.

When combining technology and exhibits, you must focus on exhibits not the technology, so when you compare 2 exhibits (say paintings), it is a more complex way of interact with the system which might make the user interact more with the technology than the exhibits whereas when you ask a question about the painting and it is answered directly, there is more focus on the exhibit and comparatively minimal focus on the technology. This conclusion is drawn from the various responses that interviewees provided, which stated the desire not to let technology overshadow the artworks. They also liked the idea of asking a question about a painting and getting quick and in-depth answers. However most participants disliked making a separate account and downloading an app for this concept so making it less intrusive without creating an account or downloading an app or providing any personal details would be a proposed change to the concept.

## **Answering the Research and Sub-research questions**

### **1. Personalization and Technology in Museums**

Participants expressed a preference for personalization in museums but emphasized that it should be simple and non-intrusive. The concept of an LLM-powered guide emerged as a promising solution, as it allows visitors to ask specific questions and receive immediate, in-depth answers. This aligns with participants' preferences for direct and non-intrusive interactions. For example, one participant stated, "I like the idea of being able to ask questions about art pieces and get quick, in-depth answers." Another noted, "I prefer technologies that are straightforward and don't require too much setup."

However, participants were generally opposed to overly complex or distracting technologies, such as AR/VR. For instance, one participant remarked, "Overly interactive features can steal the attention from the art," while another said, "I don't want technology to distract me from the actual exhibits."

## **2. Visitor Preferences for Content Formats and Interaction**

Participants were divided on their preferred content formats, with some favoring text and others preferring audio. For example, one participant noted, "I prefer reading information on plaques," while another said, "Audio tours can be nice, but they sometimes feel isolating." Formats like AR/VR were seen as too distracting for common use.

When it comes to specifying interests, participants disliked the idea of mandatory app downloads or account creation. Instead, they preferred simpler methods, such as upfront questionnaires or providing interests on-the-spot when needed. For example, one participant stated, "I would prefer a simple questionnaire or form that does not require downloading an app or creating an account."

## **3. Independence and Flexibility in Museum Visits**

A recurring theme in the interviews was the importance of independence and flexibility in museum visits. While some participants strongly preferred exploring museums at their own pace rather than following predefined or personalized routes, others appreciated the structure and informational value of guided tours. For example, one participant remarked, "I don't like routes, I don't like plans, and I definitely don't like any kind of personalized route," while another noted, "I prefer to wander around aimlessly and observe and learn." On the other hand, some participants valued guided tours for their insights but still emphasized the importance of flexibility. As one participant stated, "Guided tours can be insightful, but I like to go at my own pace." This mixed feedback highlights the need for solutions that balance structure with the freedom to explore independently.

## **4. Challenges with Current Museum Setups**

Participants highlighted several challenges with current museum setups, particularly regarding the ease of use and flexibility of technological systems. For example, one participant noted, "It can be frustrating when the technology requires too much setup or does not work smoothly." Another mentioned, "I prefer technologies that are straightforward and don't require too much effort to use."

## **5. The Role of Interests, Prior Knowledge, and Demographics**

Participants' interests and prior knowledge played a significant role in shaping their expectations of personalization. For example, one participant stated, "Depending on what I'm interested in, I might want more detailed information about certain pieces." Another noted, "I trust the information provided by the museum, but I sometimes cross-check with other sources if I'm really interested."

Regarding demographics, the sample size was too small to make probabilistically relevant remarks on the influence of factors like age or background. However, participants indicated that their interests and prior knowledge shape the type of information they seek. For instance, one participant said, "Depending on what I'm interested in, I might want more detailed information about certain pieces."

## **6. The Main Reason People Visit Museums**

The primary reasons participants visit museums are to learn and for entertainment. While they value learning, they also emphasized the importance of enjoying the exhibits and the overall atmosphere. For example, one participant stated, "I go to museums to learn, but also to enjoy the art and the atmosphere."

When it comes to accessing information, participants found the usual text plaques next to paintings sufficient for general information but lacking in specific details. For example, one participant noted, "The plaques are okay, but sometimes I want more detailed information that they don't provide." To access more in-depth information, participants often turned to external sources, such as the Internet or museum guides. For instance, one participant said, "If I want more information, I usually just look it up online later."

## **Reflections on Interview Process and Lessons Learned**

The interviews provided valuable insights into the preferences and expectations of visitors regarding the personalization of museums. However, when reflecting on the process there were several key takeaways and areas of improvement that are provided below.

### **1. What did we learn**

The interviews made it clear that visitors value personalization but they want it to be simple and non-intrusive and complementary to the museum experience. For example participants liked the idea of asking specific questions about pieces and getting detailed, accurate answers without the need to google it or asking a worker at the museum. They also expressed mixed reactions to the concept of fixed routes as some preferred to explore the museum on their own while others acknowledged that it would be a nice idea to see specific artworks that they might find interesting.

### **2. Limitations with Research and Interview Questions**

The sample size of 6 participants were statistically too insignificant to draw significant conclusions about how demographics might influence the personalization needs. Therefore, there should have been interviewees of diverse backgrounds so that we could draw more accurate and reliable conclusions based on the data.

### **Misalignment Between Goals, Research Questions, and Data**

One of the key challenges in this project was the misalignment between the research goals, research questions, and the data collected. While the overarching goal was to understand how to improve personalization in museums, some of the research questions and sub-research questions were either too broad, too specific, or not directly answerable through the interview data. This misalignment led to gaps in the analysis and made it difficult to draw clear conclusions. Some examples of this are given below:

**Research Question 1: What is the best way to solve the problem of the lack of personalization in museums?**

While this question was central to the project, some of the Sub-RQs, such as “What are the types of content formats (audio, text, visual, AR/VR) that visitors prefer?” and “How do personalized routes compare with traditional routes in terms of visitor satisfaction?”, were either too broad or required prototype testing to answer effectively. As a result, the data collected did not always sufficiently address these Sub-RQs.

**Research Question 2: What is the main reason that people go to museums?**

This question was more straightforward, but it could have been better aligned with the interview data by specifying that it referred to art museums and by including more targeted Sub-RQs.

The large number of Sub-RQs made it difficult to focus the interviews and analyze the data effectively. Some Sub-RQs, such as “How can visitors specify their interests without increasing inconvenience or complexity?”, were too broad and would have been better suited for the lo-fi prototype stage, while others, like “What are the types of content formats (audio, text, visual, AR/VR) that visitors prefer?”, were too specific and did not align well with the interview format. To address this, the number of Sub-RQs should be reduced to avoid redundancy and ensure focus. For example, instead of asking “What are the types of content formats (audio, text, visual, AR/VR) that visitors prefer?”, we could ask: “How do visitors currently access additional information about exhibits, and what challenges do they face?” This change shifts the focus from specific formats to understanding how visitors currently interact with exhibits and the challenges they encounter, which is more appropriate for the interview stage. Similarly, instead of “How do personalized routes compare with traditional routes in terms of visitor satisfaction?”, we could ask: “What are visitors’ perceptions of personalized routes compared to traditional routes?. This is because most people would not have experienced personalized routes to comment on their performance so therefore we ask about users perception instead.

**Overlap with Literature:**

Some Sub-RQs, such as “What are the challenges that museums face in their current setups with regards to personalization?”, could have been answered through a literature review rather than interviews. This overlap created redundancy and diverted focus from questions that required primary data. These questions should be excluded.

#### Yes/No Questions:

Some Sub-RQs, such as “Do people want to learn while at the museum?”, were framed as yes/no questions, which limited the depth of the responses and made it difficult to explore nuances. These questions should also have been excluded.

#### Repetition in Interview Questions:

During the interviews, some questions were repeated unintentionally, such as those about personalized routes, which could have been avoided with a more structured interview protocol.

To improve our process, the protocol should be refined to ensure all questions align with the research goals and avoid redundancy. For example, the question “Do you prefer group guided tours? Why?” should be rephrased to include a comparison, such as: “Do you prefer group guided tours over exploring independently, and why?” Similarly, the question “Do you prefer museum technologies to be highly interactive or simple and straightforward? Why?” should be rephrased to be more open-ended, such as: “What are some important aspects for you regarding museum technologies?”

Aside from the questions, there are also several other problems regarding the process that we have to address. Firstly, a pilot interview should have been conducted in order to identify the issues with the questions that we had made so we could reflect on them. Secondly, the sample size of six participants, even though it was sufficient for this project, was still too small to form more confident solutions and could have had greater diversity in terms of age, technological familiarity and museum visitation habits. Finally for the selection of the RQs, sub-RQs and interview questions, we should have had a more comprehensive analysis of their suitability and also double checked their appropriateness amongst ourselves and with the teachers/TAs so we could have avoided several of these faulty questions.

## 3.4 Final concept selection

The concept we have chosen is the LLM that answers questions given by the user. This decision is strongly supported by the interview data, which highlighted several key themes: simplicity, personalization, independence, and non-intrusive technology. Participants consistently expressed a preference for technologies that are easy to use and don't require complex setups. For example, one participant stated, "I prefer technologies that are straightforward and don't require too much effort," while another noted, "I don't want to deal with apps or logins—just let me ask my questions and get answers."

The LLM-powered system aligns perfectly with these preferences. It allows visitors to scan an exhibit and ask specific questions, receiving tailored answers that cater to their individual interests. This approach enables personalization without overwhelming the user. For instance, a visitor interested in the historical context of a painting can ask detailed questions, while another

curious about the artist's techniques can focus on that aspect. As one participant remarked, "I like the idea of being able to ask questions about art pieces and get quick, in-depth answers."

Additionally, the LLM supports independence and flexibility, which were recurring themes in the interviews. Many participants preferred exploring museums at their own pace rather than following predefined routes. For example, one participant said, "I like to wander around and explore on my own," while another noted, "I don't like routes, I don't like plans, and I definitely don't like any kind of personalized route." The LLM system empowers visitors to explore freely while still providing personalized information when they want it.

Finally, the LLM concept addresses the need for non-intrusive technology that enhances, rather than distracts from, the exhibits. Participants emphasized that technology should complement the museum experience, not overshadow it. As one participant stated, "I think technology should be used in museums so that it does not detract or distract you from the actual museum exhibits." The LLM achieves this by providing information in response to specific questions, keeping the focus on the art and history.

In contrast, the other concepts we explored such as AR experiences and personalized routes received negative or mixed reviews during the interviews. For example, participants who utilized AR found it to be overly complex and distracting, with one stating, "AR can be interesting, but it's too much effort to set up and use." Similarly, personalized routes were met with skepticism, as many participants valued the freedom to explore independently. One participant remarked, "I don't like routes, I don't like plans, and I definitely don't like any kind of personalized route." These concepts failed to align with the key themes of simplicity, independence, and non-intrusive technology that emerged from the interviews. The QR code concept, while it offered adaptability, was decided as too cumbersome due to the need for a pre-tour setup. Although users appreciated tailored content, the major concern regarding this was that it might add unnecessary complexity and disturb the natural flow of exploring a museum. Finally, the LLM-powered painting comparison tool, while engaging for some, was seen as a less practical feature compared to asking questions directly. The other major concern with this type of comparison based interaction is that it might make the visitors engage more with the technology and less with the actual exhibits, which contradicts the results from the thematic analysis.

In summary, the LLM-powered system was chosen because it directly addresses the key themes and preferences identified in the interviews: simplicity, personalization, independence, and non-intrusive technology. It provides a user-centered solution that enhances the museum experience without introducing unnecessary complexity or distraction.

# Chapter 4 - Lo-Fi Prototype

In this chapter, we will present what we believe to be the key interactions of our product, which are more or less the most important functionalities. Then we will cover our research questions, meaning what exactly we want to discover from these user studies and eventually answer these questions. Afterwards we will tackle the process, the results and the conclusions we drew from doing six user studies; during these studies we ask the participants to interact with our Lo-Fi prototype and tell us about their experience, feedback etc. This is a vital part in our project, since this is where the base functionalities of our product are changed, removed and/or validated.

We chose to use Lo-Fi prototyping because it is a low-commitment and effective way of showing users the vision we have for the product. It is quickly made, easily changeable, which for our web application is perfect, since we do not have to commit to writing any code yet. As will be later shown in chapter 4.2, we have used a free online tool called Figma to quickly put together the outline of a web application on a virtual phone, controlled via a laptop. More details about the prototype itself and the interaction of the user with it will be explored under chapters 4.2 and 4.3.

## 4.1 Research goal

The team found most important for the process the following interactions: the first one is selecting the mode (regular/researcher/child), this is the first step of personalization in our web app, by selecting one mode, the LLM guide will provide information at a tailored level of detail for one of the classes; the next interaction is scanning an art piece, by pointing the phone camera at the piece or choosing an art piece from the database; the last interaction is asking a question, after scanning a painting, the user is prompted to a chatbox, where premade questions can be selected, or a new one can be written. The last interaction helps in personalizing the experience, by slowly adjusting the content that the guide shares after a picture is scanned, by already including details that the user asked previously for. When it comes to their importance, we have ranked the key interactions the following:

1. Asking a question: this is the main “selling point” of our product, the core solution to our problem; since we want to develop a chatbot tour guide, the chatbot part is obviously the most important.
2. Scanning an artwork/selecting from the database: this is also very important, because we believe this makes or breaks our product; if the process of selecting a piece is not easy, fast and understandable, then people would not want to use it.

3. Selecting a mode: this would be a nice feature to have, since it could attract a wider range of people of different ages and with different interests; ultimately, it is not integral to our product, but it is something we would like to implement.

For each interaction, the team devised a scenario that represents it. These scenarios help better understand the reason these key interactions exist, why they are important to our product and one of the ways they could be utilised.

## Scenarios:

### Selecting a mode

Henry is a math teacher with a passion for art, who likes visiting museums. Henry is also a father and his 2 boys are 10 years old. He is trying to get them into art as well. Today he takes them to a new art exhibition. At the entrance, he finds out about the new system this exhibition is using. He scans a QR code and gets access to a website. Here he can interact with an LLM tour guide and can change whenever he wants the level of detail of the information about the exhibits he gets. He is very pleased because now he can get very detailed information for himself, as a person who is passionate about this, and the basics are tailored into a more accessible way for the kids.

### Scanning an artwork

Mark is an avid museum visitor, but every now and then confronts a situation that he dislikes. He has to follow big groups that make a great deal of noise and crowd next to the information plates describing the exhibits, making Mark's experience less enjoyable. Today he visits the art museum in a neighbouring town. At the entrance, one member of the staff lets Mark know about a new feature of the Museum, an LLM-powered tour guide. Mark decides to test the new feature, so he follows the introductory steps, by scanning a QR code that points him to a web app. Now, Mark proceeds to walk throughout the museum and sees an exhibit that appeals to his curiosity. He proceeds to scan the artwork using the web app. He gets generic information (about the painting, what it represents and the year) as a response from the web app and is pleased that he can get it so fast and quietly. He goes on to visit more art pieces.

### Asking a question

John enjoys visiting museums but feels like he's usually slowing down the tours because he asks many questions compared to other visitors. John already has a screen in front of him with the chatbox, because he has scanned the painting. John observes 3 predefined questions that are offered to him as soon as the chat box is opened: "How does this painting reflect Impressionism?", "Why is Water Lilies significant in art history?", "How do light and reflections shape the scene?". John chooses the first question and presses the corresponding button. After the system processes the question request and prints out the answer from the database. "Monet's Water Lilies paintings are quintessential examples of Impressionism, showcasing the movement's emphasis on capturing the fleeting effects of light and atmosphere. ...". After getting the answer John realises that he wants to know more information about the painting. John starts to type in his question "Why did Monet decide to paint lilies and not any other

flower?" letter by letter. After finishing phrasing and typing in the question John presses the button "send" to get the answer back. The system gets the question and is searching through the available database for an answer. After a few seconds, the system provides the response on the screen "The painting depicts the flower garden that Monet had at his home in Giverny. Lilies were the main focus of Monet's artistic production during the last 30 years of his life."

## Research Questions:

Each of the research questions(RQ's) are linked to one of the key interactions. Their purpose is to help us better understand what users think of these interactions, what they would change or what they dislike, what they are comfortable with etc. These are the main questions we had regarding designing the product. Some questions are more broad and need one or multiple sub-research questions(sub-RQ's) to help break down the question into individually answerable pieces. The RQ's and sub-RQ's we have found are the following:

RQ1: Would users like different difficulty modes?

RQ2: What is the best way to select which art piece you want to get information about?

Sub RQ1: What method of choosing a painting do users prefer?

Sub RQ2: Are users comfortable with giving their camera permission?

RQ3: How would the visitors ask questions about the exhibit?

Sub RQ1: Would visitors like predefined questions presented to them after scanning an exhibit?

Sub RQ2: How would the predefined questions be chosen for each exhibit?

Sub RQ3: In what manner would these questions be shown to the user?

Sub RQ4: In what way would the visitor get the answer to their questions regarding the exhibit?

## 4.2 Methods and materials

For this Lo-Fi prototype “journey”, we went through 3 design phases: making a list of the features we want and sketching them on a whiteboard (Figure 4.1), then making a pen and paper

drawing of the UI with no actual functionality (Figure 4.2), then using Figma to design each screen and add limited functionality (if you press certain parts of the screen it takes you to another screen, but everything is static so no actual functionality) (Figure 4.3). For clarity, Figma is a free online website which makes creating these types of designs really easy. You can make multiple pages, almost like making a presentation, and then link them using buttons, without any code, so people can get a better feel of the application’s flow.

### 4.2.1 Design process of Lo-Fi prototype

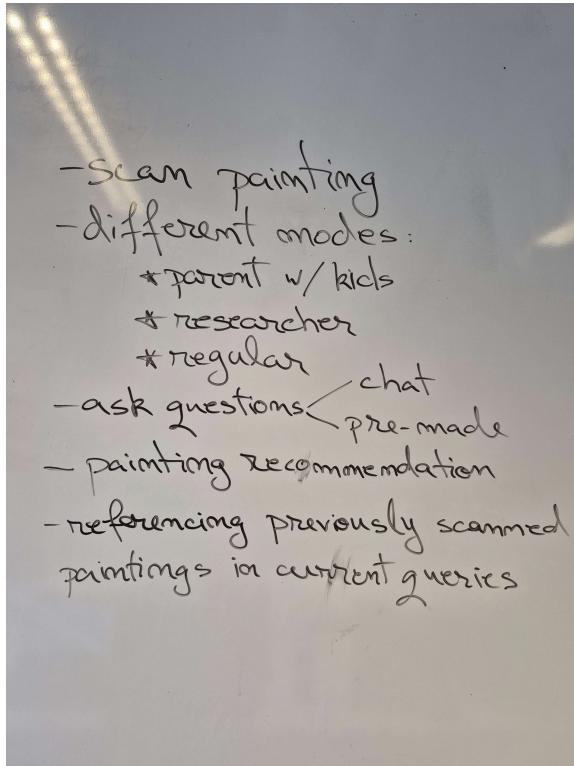


Figure 4.1

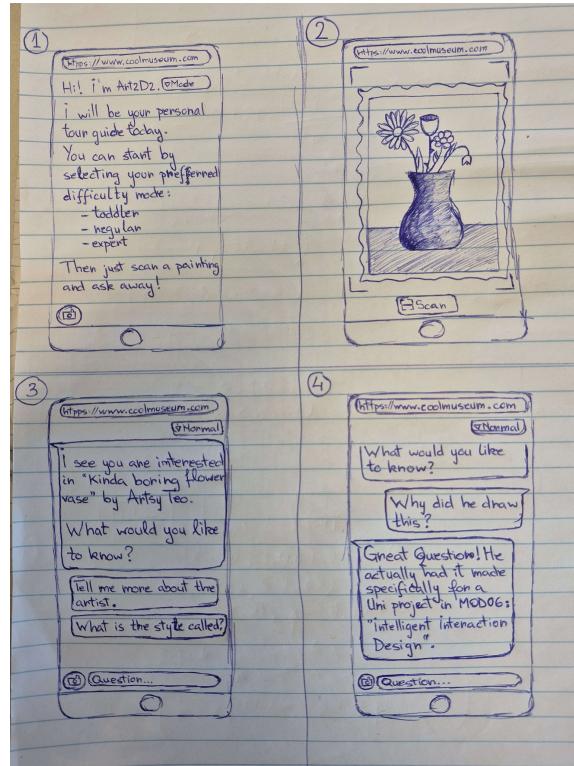


Figure 4.2

From these, we thought whether it is enough to have the paper prototype or whether it is necessary to do a more interactive prototype. Since we are making a web application, we believe that the most important thing we can learn from this is how users interact with it. They might be more inclined to click around and try buttons if we give them something a little more “techy”, so even though working with Figma adds a little more complexity, we decided to go through with it.

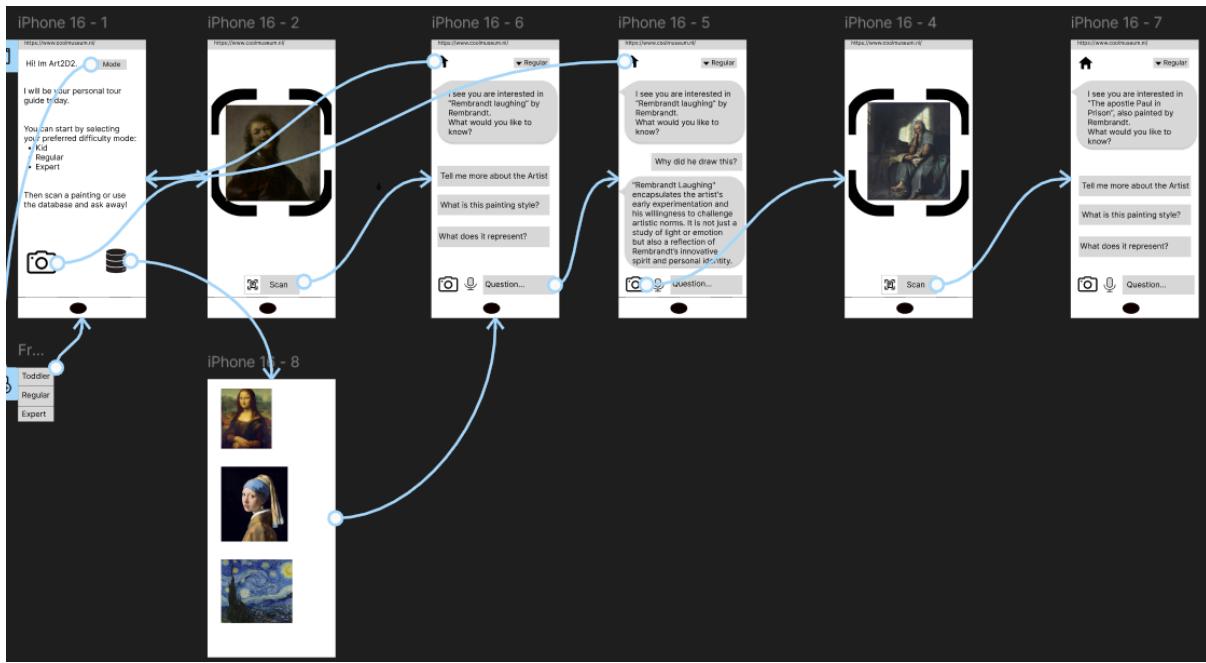


Figure 4.3

Figure 4.3 is a screenshot of the “backend” of our Lo-Fi prototype. There can be seen all the different pages that were created and the blue arrows, which indicate the connections between each page. The source of the arrow indicates which button on the page can be pressed to lead to another page, which is indicated by where the arrow is pointing. Next, we will present each page individually and explain its purpose.

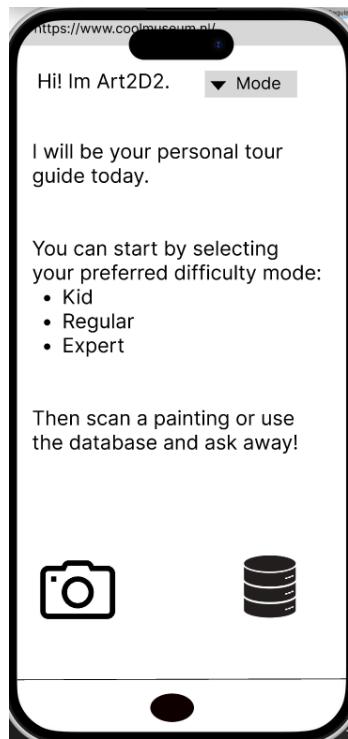


Figure 4.4



Figure 4.5

Figure 4.4 is the homepage of our product, which we called “Art2D2”. There we get a short introduction of what you can expect from the web-app, with buttons that let you change the mode, go to the paintings database or go to the scanner function. If we press the camera icon, we are taken to Figure 4.5, where we would have to put the painting into frame and press “Scan”. If we press it, we will be taken to a chat, which we will see next.

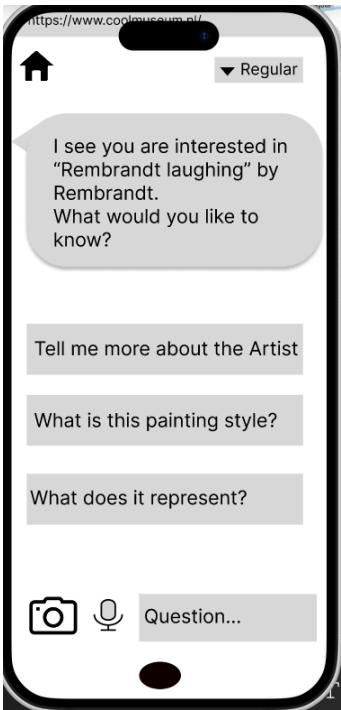


Figure 4.6

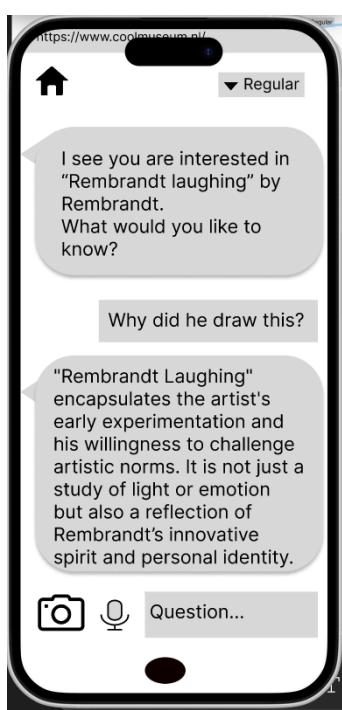


Figure 4.7

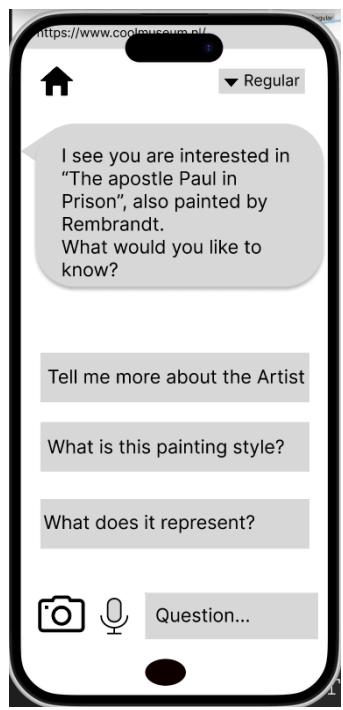


Figure 4.8

In Figures 4.6, 4.7 and 4.8 we can see different examples of chat interactions. Figure 4.6 shows what a user would first see after scanning a painting: title + painter of the piece they just scanned, 3 premade question options and buttons. In Figure 4.7 we can see the chatbot answering a question and in Figure 4.8 it is highlighted that the chatbot references a previously scanned painting, because it has in common that both are painted by Rembrandt.



Figure 4.9

In Figure 4.9 we can see the database, which would appear if we clicked on the database button in Figure 4.4. Here the user can select a painting by clicking on it instead of scanning it, if for whatever reason they do not wish to/can not use their camera.

## 4.2.2 Study Protocol for the Small-scale User Test

To get a successful protocol, we need to keep in mind the objective: evaluate the effectiveness and usability of our prototype for an LLM art museum tour guide. To this end, we need to evaluate multiple things. Most notably the combination of features that the user interacts with. And how this interaction can be made as good as possible. Therefore, we have number of RQs:

1. What is the best way to select which art piece you want to get information about?
  - a. What method of choosing a painting do users prefer?
  - b. Are users comfortable with giving their camera permission?
2. How would the visitors ask questions about the exhibit?
  - a. Would visitors like predefined questions presented to them after scanning an exhibit?
  - b. How would the predefined questions be chosen for each exhibit?
  - c. In what manner would these questions be shown to the user?
  - d. In what way would the visitor get the answer to their questions regarding the exhibit?
3. Would users like different difficulty modes?

Furthermore, every interview is conducted by 3 people, this is so that as much high quality data is collected as is possible while minimally reducing the quality of said data. The roles of these three people are defined as follows:

- Facilitator: Talks with and guides the participants
- Observer: takes notes and observations about participants
- Data Recorder: centralises and organises measures

Finally, we inform the participant of a number of additional stipulations that apply to the user study:

- Brief overview of the study and its purpose
- Make participants sure that their feedback should be about the prototype, not their performance
- Explain in general the tasks
- Ask them to explain their thought process , while they are testing the prototype
- Inform them about the duration of the study and about the follow up short interview

## Study Tasks

After a brief introduction to the goals of our project, we collect the demographics of the study group. Next, we introduce the prototype to the participant with the instructions to test the prototype. Firstly, different modes are presented to the participant, and they can choose one from them, otherwise the default mode is activated (i.e. the regular mode). After entering one of the modes, the user has a choice of scanning one using the camera of the paintings or choosing one of them in the database. After that the user is presented with the name of the painting and the author of the chosen piece of art, and is presented with three options of possible questions about the painting to start the dialogue. The user needs to choose one of those questions or already can start typing in their own question about the painting. The dialogue continues until the user has asked the questions desired, and after that the loop starts again, and the user can scan it again or choose it from the database. After the testing is completed, we ask participants to reflect on their experience.

## Measures

- Quantitative:
  - Time: how much it took to complete a task
  - Error number: how many errors per task
  - Success rate: how many users finished the task / all users
- Qualitative:
  - Post-task rating (Likert Scale, 1 to 5 rating)
  - User feedback after completing a task
  - Observations about user behavior (how they react to features in our prototype; we will use this to determine whether such features are liked, useful, or understood)

## Post Interview Questions

- What were the features you liked in this project and what were the features you disliked?
- What do you think about the personalized features? Is it too little (if so what could be added) or too much or just right?
- If you had the choice of using this in a museum, would you use it, if not, why?
- What do you think about choosing a mode?
- Scanning/database (QR code or painting)
- How do you feel about the model remembering your previous visits to paintings and hence creating a more tailored experience.
- How did you find the predefined questions? Were they helpful?
- Would you like to rate each feature from 1 to 5:
  - 1- tedious, 3-neutral, 5-awesome
    - there are 3 tasks :
      - choosing the mode
      - scanning
      - asking a question

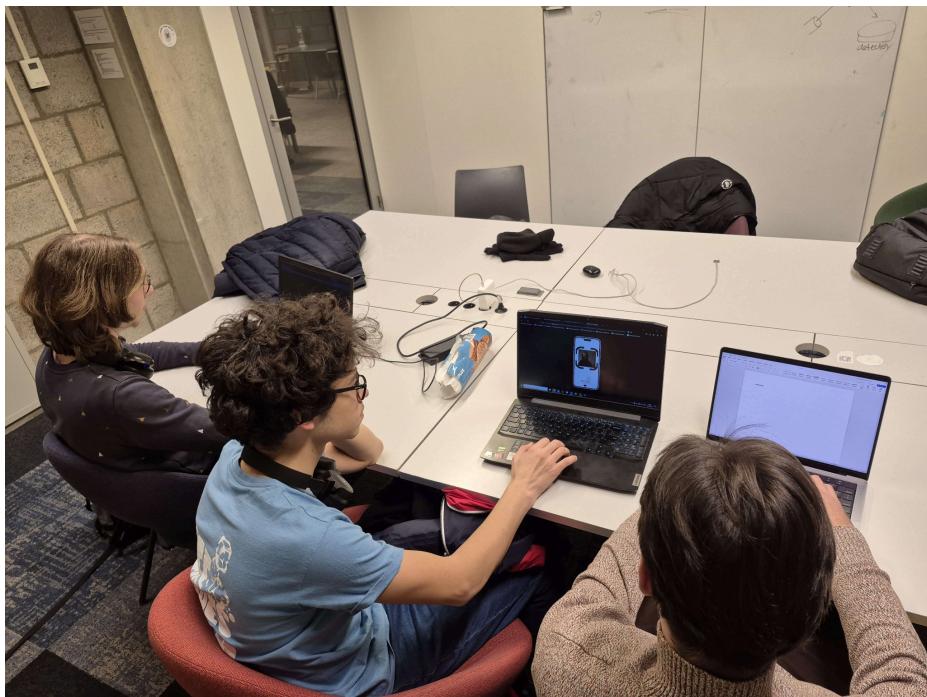


Figure 4.10

This is the interview setup (Figure 4.10). We had the user (this case, guy in the blue T Shirt) that would use the prototype and give feedback, then someone who walks the user through the User Study, and a third person taking notes.

In total, we did 6 User Studies. Names or direct personal information will not be mentioned throughout this document, but we have the following demographics: the total age range we have interviewed is between 20-36 years old, both male and female and they were all representing themselves going to a museum and trying out this new technology they have no previous experience with.

## 4.3 Results

As established, this user study aims to gather feedback regarding the key features of the product, such that it matches most user's needs. Thus, we read each interview and decided that it would be ideal if we break them down and organize them into sections that have a common theme. Because of this, the team concluded that a thematic analysis would highlight the findings the best.

### 4.3.1 Thematic analysis

The thematic analysis entails that we find common talking points between the interviews, which we use to draw a conclusion about that specific topic. The purpose of this analysis is to identify how many of the users express a certain opinion, so that we can distinguish between a one-off (which is still important and taken into consideration, but less popular) and a more popular opinion, which we will apply to the design. For this purpose, with a very limited pool of six users, we decided that if at least half the users share a certain opinion (in our case, three), then that is considered a "popular opinion" and the respective feedback will be applied.

After analysing the user studies, we identified the following themes: database functionality, front page design, fine-tuning the modes, scanning methods, chatbot interaction and quiz implementation.

#### Theme 1: Database functionality

The participants had mixed feelings about the database functionality. One person appreciated the alternative for scanning, but the lack of navigational features like search bar, filters and scroll bars made three of the users feel overwhelmed. Moreover some of the study participants said that they were confused over the database's actual purpose. Finally the participants suggested adding navigational features like filtering, sorting and searching to increase the usability. And also to add a way to explain the database's purpose and features.

## **Theme 2: Front page design**

The front page design was noted by a few participants. Two of the main issues are the layout and navigation. For example, one person mentioned that because of the layout they did not notice the possibility to choose modes (it was in the right upper corner). Also, someone else expressed that they did not like the overall design of the front page. Additionally, another user mentioned the front page as well; they found the user interface lacking in appeal and design, suggesting the need for significant improvement. A few suggestions were made, one of which was choosing the mode in the middle of the home page, compared to its original position. Besides, the issue with the home button on other pages was mentioned. There was no home button to go back to the home page, and hence access the database option, so participants could not test it out if they had not tried it as the first action (Note: the home icon is there in Figures 4.6, 4.7 and 4.8, but the button was not connected to the home page). Participants called for both structural and aesthetic improvements, such as switching layout for easier interactions, providing a more user-friendly interface, and ensuring the home page is visually appealing and accessible.

## **Theme 3: Fine-tuning the modes**

Four of the users had feedback regarding the mode selection feature. Many liked the fact there was a way to tailor the level of detail they could get. One particularly praised the accessibility enhancement for the younger audience.

On the other hand, there was also negative feedback regarding the way this feature is presented. Two users felt that the modes had unclear descriptions and naming conventions, which led to confusion. Also someone said that the positioning and lack of clarity of the mode selection

Caused navigation issues on the whole page.

Overall, there were some suggestions like adding a clear, concise description regarding each mode on a starting page and also positioning the mode selection toggle bar in a more prominent area for better visibility.

## **Theme 4: Scanning methods**

Participants were made aware of the different ways which they could use to interact with the chatbot such as scanning the painting or the QR code. Two of the users had no preference of one over the other: "It does not really make a difference", while three others preferred to use the QR code due to its simplistic and easily understandable mode of interaction: "It's easier to use and implement". However we did also get several comments from different interviewees stating the need for clearer instructions mentioning that a QR code has to be scanned as well as notifications that inform users to hold the camera steady which allows for easier scanning: "Maybe something like an instruction that tells you to scan a QR code or a painting or hold the camera a certain way".ent

## **Theme 5: Chatbot interaction**

The overall opinion on the chatbot interaction was positive. The feedback received was mostly about the predefined questions and the system's ability to remember previously scanned artworks. All 6 users have expressed positivity towards using the chatbot, with one commenting about the predefined question that "I didn't know what to do with them, they do not look like clickable buttons". Otherwise, they mentioned that the predefined questions are something they would ask in a museum. The feature of remembering previously scanned paintings, on which only three out of six users commented, was also positively received. One user stated "It's nice, it gives more context to why and how those paintings are related".

### **Theme 6: Quiz implementation**

Initially, there was no intent to create a quiz feature. It is not part of the lo-fi prototype, nor the presented concept so far. However, during one of the user interviews, the idea was brought up to be able to ask the chatbot for a quiz about the pieces scanned in order to test the user's gained knowledge. The team liked this idea, so after that interview users were also asked about their opinion on a quiz feature. For this reason, not all interviews mentioned a quiz.

With this in mind, all three interviewees that talked about the quiz had very positive feedback about it. One specific user, who is a parent, mentioned that the quiz would help keep children more involved: "I would like some sort of activity that would engage my children". Other mentions of the quiz also put the idea in a positive light, such as: "A quiz would be cool, so I can actually test if I've learned anything".

#### **4.3.2 Likert scale rating for key interactions**

Another part of the study was getting the key interactions of the prototype rated using the Likert scale. As stated in the protocol, we asked the users to rate our three key interactions from 1 to 5, 1 meaning "tedious", 3 meaning "neutral" and 5 meaning "awesome".

The results are summarized in Table 1:

<b>Key Interaction</b>	<b>Overall Sentiment</b>	<b>Likert Rating Average</b>
<b>Mode Selection</b>	Convenient, but confusing labels	3.8
<b>Scanning</b>	Highly useful, QR codes preferred.	4.5
<b>Asking a Question</b>	Valuable but needs more flexibility	3.7

Table 1

Even though our sample size of 6 people is not large enough to facilitate the need of a Likert scale, we still thought we could get some valuable information from it. For example, we can see that we need to rethink how we want our chat to function, since it is our most important interaction, yet it has the lowest average. Next we see that the mode selection has the second lowest average of 3.8, which is understandable since in retrospect, we did not outline the modes properly. Then for scanning, we have a high average of 4.5/5, which tells us that people like the concept and all we need to do is implement it. All this information will help us answer our RQ's and develop the product further.

## 4.4 Reflection and iteration

The findings from the interviews provide valuable insights which we used to refine the concept of the Lo-Fi prototype. While many features were appreciated by participants, several areas need improvement to ensure a smoother and more intuitive user experience.

Initially, the database functionality, several participants found overwhelming due to the absence of navigational aids such as search bars, filters, and scroll options. This feedback suggests a need to incorporate these features and provide clear explanations about the database's purpose to improve usability as well as change the icon to make it more easily recognizable for everyone. Despite its current limitations, retaining the database feature is essential as it offers users an alternative way to engage with the artworks.

The mode selection feature is going to stay due to positive feedback however there was some ambiguity in the difference of the modes. To resolve this, concise and intuitive descriptions of each mode will be included. The ability to switch modes during a session was well-received and should remain unchanged as it adds flexibility and personalization to the user experience.

In addition to this, there is also a possible added functionality of quizzes that users can take part in during their tour of the museum. They can ask the chatbot to quiz them about all the paintings that they have visited and then it gives a series of multiple choice questions that the user needs to answer.

Additionally, the feature where the user scans paintings will be replaced by QR codes next to the paintings which visitors need to scan in order to communicate with the chatbot. There are also clear instructions indicating that the user needs to scan the QR code.

The predefined questions and chatbot features were largely appreciated for their convenience and functionality. Many users found the predefined questions helpful in starting a dialogue and valued the chatbot's ability to tailor responses based on past interactions. The personalization aspect of the chatbot, which remembers users' past interactions, was especially praised and should remain a central part of the system.

All of this feedback, both positive and negative, has helped us answer our RQ's and Sub-RQ's. These will help us make user-centered decisions and shape the future of the product. Here are the answers we came to:

**RQ1:** Would users like different difficulty modes?

**Answer:** The majority of participants enjoyed the feature of different modes, different modes that are tailored to different groups and complexity and extensiveness ensure the accessibility for a diverse audience.

**RQ2:** What is the best way to select which art piece you want to get information about?

**Answer:** It is to choose the wanted QR-code that is next to the painting that you want to learn more information about, or to firstly get an overview of all paintings in the room, and choose one of those.

**Sub RQ1:** What method of choosing a painting do users prefer?

**Answer:** From the interview answers, the majority prefers to utilize QR-codes for scanning the paintings, instead of scanning the painting itself as they are more comfortable and common to use by users.

**Sub RQ2:** Are users comfortable with giving their camera permission?

**Answer:** The majority of the participants enjoyed the experience of scanning, better than accessing a database. Most of them were okay with giving permission to access the camera.

**RQ3:** How would the visitors ask questions about the exhibit?

**Answer:** In a chat box via choosing one of predefined questions or typing in your own.

**Sub RQ1:** Would visitors like predefined questions presented to them after scanning an exhibit?

**Answer:** A lot of participants expressed that they enjoyed the feature of having provided questions that you can choose from to start a dialogue.

**Sub RQ2:** How would the predefined questions be chosen for each exhibit?

**Answer:** They would be chosen based on the history of scans and questions and mode level, so the questions that are provided to the user are personalized.

**Sub RQ3:** In what manner would these questions be shown to the user?

**Answer:** The questions would be presented as floating bubbles, in a font and size that does not take too much space, but are still easy to see.

**Sub RQ4:** In what way would the visitor get the answer to their questions regarding the exhibit?

**Answer:** The answer would be provided in a textual form, accompanied by visuals in some cases.

Overall, the team definitely learned things that would have been difficult to figure out without doing these user studies. For example, as mentioned previously, valuable feedback was given on the database functionality, of adding filters and a search bar. Additionally, the absence of

complaints in certain areas can be interpreted as positive feedback, suggesting that certain aspects of the concept are already on the right track.

No inherent problems were identified with the concept or the research questions. The enthusiasm for the project is shared by participants, further affirming its potential. Reflecting on the process, there is curiosity about whether using a pen-and-paper prototype instead of a digital one, such as the Figma-based version used, might have yielded different insights into user interaction. Although no regret exists regarding the choice of Figma for representing a web application, this consideration highlights an area for potential exploration in future iterations.

Something that needs to be mentioned however is a change between the concept, as explained in Chapter 2, and what the lo-fi prototype presented. There was a “how it works” chat page meant for tech-passionate people where they could have their questions answered about the training data, the scanning functionality and other technical details. The decision was made not to go through with that for two main reasons. Firstly, it strays away from the purpose of the product. It is quite the reach to make a feature for tech-savvies in an application for everyday art museum goers. Secondly, it no longer matches the design. As mentioned above in the findings of the User Studies, the scanning feature will use a QR code instead of a ML model that recognizes each painting. Thus there is no training dataset, nor any in-house AI feature that should be explained. Only the Ollama application is used to run Llama (LLM), and it has online documentation.

Regarding the testing phase, it was generally successful, though room for improvement still exists. Setting up for interviews went slower than expected, so only 3 interviews were able to be done in the allocated time, which meant the other three had to be done outside of class hours, where people were harder to find. One other thing that could have been improved on is the first interview. Instead of letting the user play around with the prototype, the facilitator accidentally talked them through it, which meant less valuable feedback was received, since their authentic reaction to our concept was not captured. This does not mean that their feedback was useless, but it is something that could have been prevented. Adjustments were made in subsequent interviews, with the remaining five conducted using the improved methodology.

# Chapter 5 - Hi-Fi Prototype

A High-fidelity prototype, or hi-fi, is a more detailed and automated representation of the prototype compared to the Lo-Fi prototype. While lo-fi prototypes focus on basic structure and interaction flow, hi-fi prototypes refine these elements with realistic visuals, interactive components, and improved user engagement. High-fidelity prototypes look and behave as close as possible to the intended final product. During this stage of the project, the functionality of the prototype was expanded, and technical limitations were identified. Additionally, the High-fidelity prototype was implemented as a web application, compared to a downloadable application.

Additionally, after consideration of the feedback from the Lo-Fi prototype, the Hi-Fi is going to have the search bar in the database, and filters to navigate the search in the list of available paintings. Moreover, we will ensure that the Homepage button is working for ease of navigation. Furthermore, on the webpage where the user is going to scan the QR code, it is going to be ensured that after scanning the QR code, there is an identification of it. After processing the feedback from the Lo-fi prototype, another feature that was appreciated is predefined questions, that is going to be reflected in the Hi-Fi prototype.

Nevertheless, the advanced prototype follows the interaction flow that was introduced in the Lo-Fi prototype. The fulfillment of this stage is needed to gain deeper insights into user interactions, evaluate the appropriate modalities for the design, and address challenges associated with the concept. Besides, it allows for a more realistic simulation of user experience, because it is possible to observe the user-prototype interaction in a practical context. Moreover, conducting user testing with the prototype allows to collect the feedback on and examine the behaviour of the system on specific design elements, such as navigation, responsiveness, and accessibility, as it is a near-final representation of the product.

## 5.1 Research goal

This section outlines the key interactions with interaction scenarios and focuses on understanding and refining interactions within the concept of the project. Additionally, the section presents the research questions which were based on the key interactions.

### 5.1.1 Key Interactions

This subsection shows the key interactions designed to provide the main functionalities that need to be designed for the chosen concept. Each interaction portrays a distinct purpose, which allows the potential users to interact with the concept in a meaningful way, whilst applying the concept of being user-friendly.

The main interactions that were identified for the Hi-Fi prototype are :

- Selecting a painting to ask a question about
- Asking questions to the chatbot
- Personalized quiz

### **Interaction Scenario: Selecting a painting to ask a question about**

This interaction allows users to choose the method of selecting an art piece. At the home screen, the user is met with a page where they can scan a QR code or select an image from the database to start a conversation with. After which the user does not need to specify the context of the conversation because the chatbot is going to be aware of the context.

1.1 When the user selects the first option(scanning QR code), the system transfers the user to the scanner. Whenever the user scans a QR code, for example, they scan the QR code that is next to the “Black Square” painting, then they are then transferred to the chat box, given the description of the painting and the system then asks the user to ask follow-up questions , such as “Oh, Black Square is an interesting painting. What would you like to know about it?”.

1.2 If the user selects the database option, the system shows the list of available images. For example, the list of 3 paintings would appear: “Black Square”, “Red Square”, and “Composition with Red, Blue and Yellow”. The user can choose a painting by scrolling the list of available paintings and clicking on it, or could also use the filtering feature on top of the database page, which can filter on different characteristics, such as year, painter, style, etc. Then they are then transferred to the chat box as well, and are given the description of the painting, the system then asks the user to ask follow-up questions

### **Interaction Scenario : Asking questions to the chatbot**

This interaction allows the user to gain the desired knowledge about the art piece via communicating with the chatbot.

2.1 First, the user should select the painting to ask questions about. Then, the user is being redirected to the chatbot page, where they can ask questions about the painting at the bottom of the page in the chat input field. For example, “Which historical event does this painting portray? ”.

2.2 Then the answer is sent to the AI model that processes the question, and tries to find a relevant answer from the information in the database that was given by the museum. If the answer is found, it returns the answer, for instance, “Oh, that’s an interesting painting, it portrays the Battle of the Trafalgar....”. If the answer was not found, i.e. no such information was provided by the museum or the input is unrelated to the painting, then the returned answer would be “I do not know the answer to this question.”

## Interaction Scenario : Personalized Quiz

This interaction allows users to test the knowledge that they have gained from interacting with the chatbot in an educational and interactive way.

3.1 When the user clicks on the quiz button at the top of the page, the bot creates the first question regarding visited paintings, such as “When was this painting finished?”.

3.2 After reading the question, the user enters the answer - (continuing the previous example) - “1930”, and clicks the send button.

3.3. The bot checks whether the answer is correct, and if it is, returns “That’s correct”, and continues to generate the next question.

## Changes in Key interactions compared to the Lo-Fi prototype

In comparison with the Lo-Fi prototype interactions, there is one interaction that did not undergo any changes - “Asking questions to the chatbot”. This interaction remained unchanged as there were no required changes in the communication part of the user interaction flow.

For “scanning” interaction the expansion of the interaction possibilities needed to be included, because the user, if they do not want or can not provide access to the camera, is given a choice to select the painting from the database page.

As for the last interaction from the Lo-Fi prototype, “selecting the mode”, was changed to the “personalized quiz”, as during the evaluation of possible implementations, the limitation of properly implementing the modes to the AI model arose: it would be too much information for the LLM to process, hence, there might be a greater chance at for a model to hallucinate the answer. Besides, the quiz received very positive feedback during the Lo-Fi user testing, hence with regards to the limitation faced for the modes feature , and occurrence of the quiz idea that was welcomed by the participants, we decided to switch one of the key interactions.

## 5.1.2 Research Questions

For each of the key interactions mentioned before the research questions were created.

RQ1 : Do users understand all the features of the product from the first page?

The first question ensures that for the initial user interface the navigation is clear and intuitive from the first seconds of using the app and has its core functions implemented. This will be evaluated by users either trying the features that are presented in the first page, namely the chatbot and database selecting features, or by mentioning them during the outloud walkthrough.

RQ2 : Are the ways of choosing a painting easy to navigate?

Sub RQ1 : Does scanning the QR code feel intuitive?

Sub RQ2 : Does the filtering feature of the database make it easier to explore?

The second question aims to determine if the options of choosing the painting are user-friendly and effective in accessing desired information.

RQ3 : How can we incorporate the quiz?

Sub RQ1 : Do users like the quiz within the chat conversation?

Sub RQ2 : How difficult should the questions be?

The third question aims to determine the engagement and comfortable difficulty levels of the quiz for the users. The difficulty level is going to be evaluated by the feedback of the user during the interviews.

RQ4 : Does the conversation with the chatbot feel personalized?

The fourth question aims to evaluate whether the chatbot responses are tailored and relevant, rather than generic.

RQ5 : Would a user prefer our product over traditional ways of researching?

The fifth question aims to compare the user experience of using traditional methods with developed app, and determine whether the app provides a more engaging, personalized, and efficient experience.

## 5.2 Methods and materials

This section provides the methods and materials used in design and development of the Hi-Fi prototype of the museum application. The chapter focuses on the visual representation of the application, design choices and reasoning for making them, technical description, and smart services that make the hi-fi prototype an intelligent interaction.

The Hi-Fi prototype represents an advanced and more automated version of the museum application to interact with, that is designed to simulate the final user experience as closely as possible. The prototype builds on the Lo-Fi version by enhancing its design fidelity, interactivity, and overall usability. The Hi-Fi prototype implements key functionalities of the Lo-Fi prototype that were identified in the previous chapter. A number of enhancements were based on the user feedback from the previous phase. Such as for the database adding the filters and search bar, and implementation of quizzes. Other ones were an improvement of key features, such as implementation of the chatbot and physical scanning of the QR codes, instead of figma prototype with preset questions and answers and a picture of the QR code, respectively. Overall, the fidelity of the prototype was improved by upgrading the visual and interactive elements to match the quality of a finished application, ensuring the prototype effectively communicates the intended experience. Development of the Hi-Fi prototype allowed for expansion of features while acknowledging the technical limitations of the system.

### 5.2.1 - Prototype Overview

The prototype was created using a combination of web development tools and frameworks, focusing on implementation of all required features and improvement of user-interaction flow. The application consists of interconnected web pages designed for ease of navigation. The home page serves as the entry point, allowing users to scan QR codes or access the database. Users can view, filter, and select paintings from the database, or directly start communicating with the chatbot for context-aware interactions after scanning the QR code.

A list of paintings with their description is storing the information provided by the museum, while the chatbot model processes natural language queries. Personalized quizzes are accessible via the chatbot page, providing a possibility for the user to test their knowledge in an engaging way.

#### Web pages:

##### 1. Home page

The first page is the home page. This is the main point of entry for the users. One of the things that is possible to do on the web page is to scan a QR code, after the user has given permission to the device camera. From the home page it is possible to access the database page as well. Hence, all of the key functionalities are introduced on the home page.

2. Chatbot page

Another page is the actual chat with the bot page. This is the page with the main interaction for the user. The chatbot processes requests in natural language, and verifies with the information provided in the database of the museum, and returns the answer. If the answer is not known, then the user will see the equivalent of the phrase "I do not know".

3. Database page

The database can be accessed through the database webpage, where the user can view the catalogue of paintings, filter them, and choose the one desired to have conversation about. After that the user is navigated to the chatbot page.

## The summary of the user interaction flow

The user firstly goes to the home page, where they can choose between two key interactions: asking questions to the chatbot (done via scanning a QR code) or selecting a painting from the database to ask a question about. The last interaction that was identified, i.e. personalized quiz, can be accessed through the chatbot page.

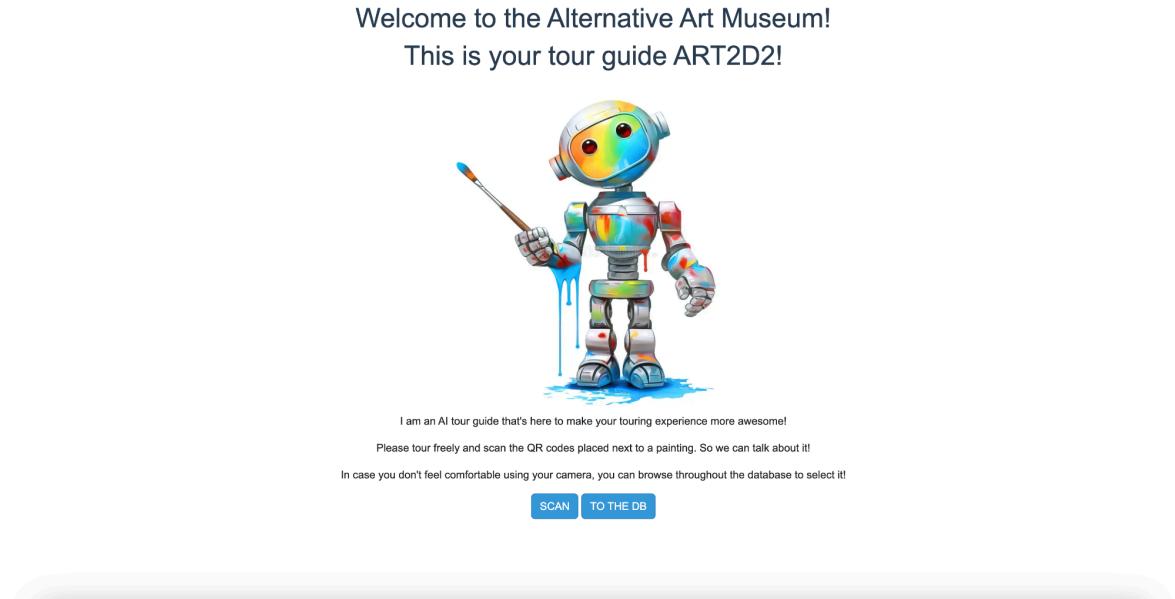


Figure 5.1

This is the welcome page of the developed web application, i.e. the home page. Where you can see an overview of possible interactions. Users can either scan or go to the database. This is the picture of the entry point for the user.

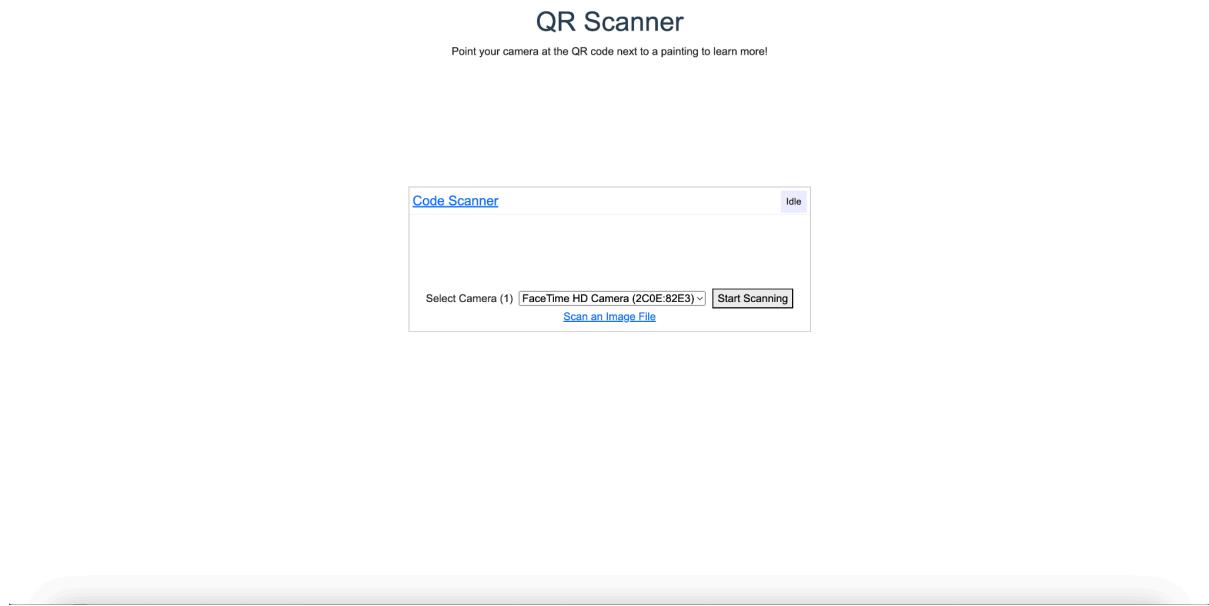


Figure 5.2

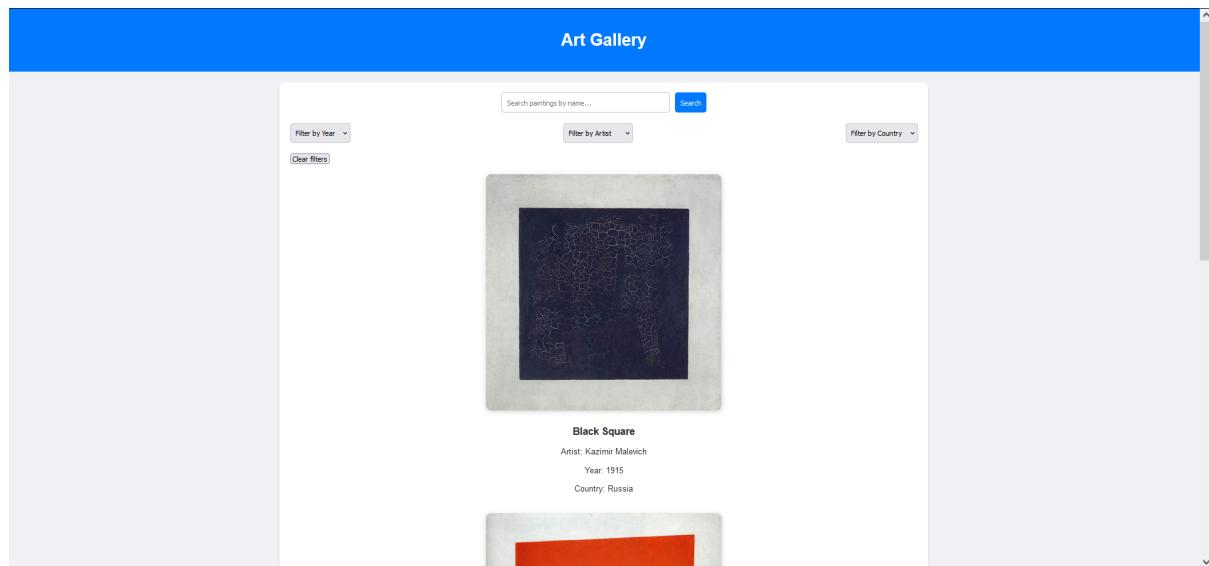


Figure 5.3

Then the user can perform one of the key interactions: selecting a painting to ask a question about. In the pictures provided, there are two ways of choosing the painting, either to physically choose a painting and scan a QR code, or to choose from the provided database.

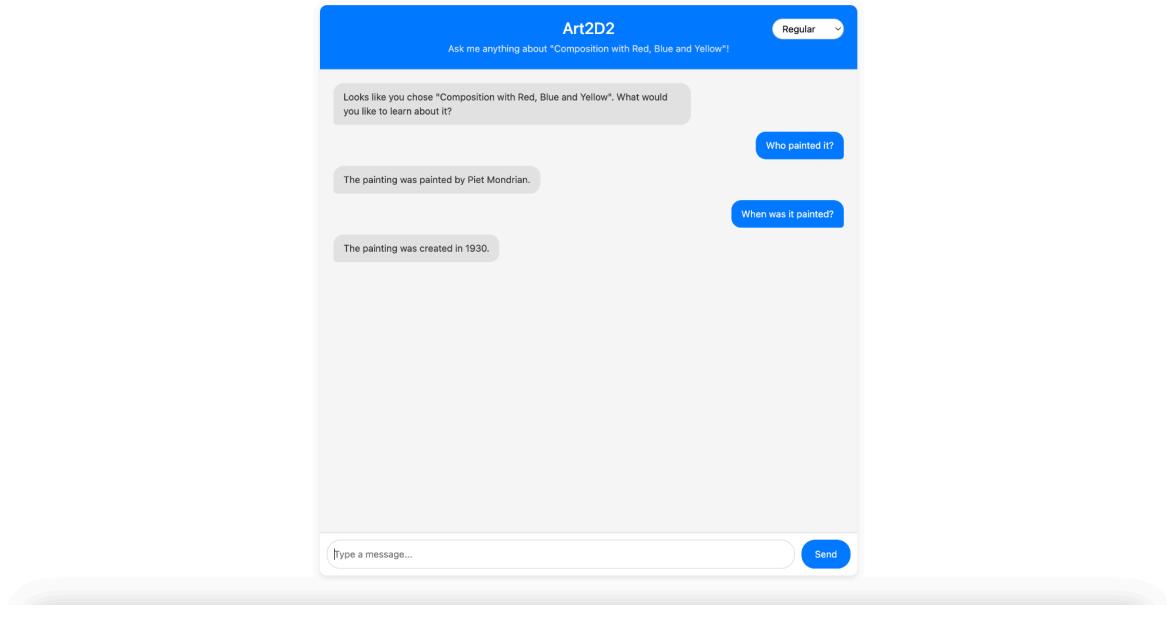


Figure 5.4

After that, the user is redirected to a page with a chatbot that already knows which painting the user wants to have a conversation about, and can start asking questions right away.

### 5.2.2 - High-level Technical Description

#### Backend development

The backend was developed utilising Flask, which was chosen as it works in combination with python, and is quite flexible framework. For the chatbot Ollama was used as the AI model.

#### Frontend development

The frontend is developed using HTML, CSS, and JavaScript, following standard practices for web application development. Key pages were designed with the necessary functionalities, such as filtering options for the database of paintings. A detailed description of these web pages can be found in the prototype overview. In addition, to access the user's camera, i.e. to ask permission to utilize it, the MediaDevices.getUserMedia() method, a part of the HTML5 WebRTC API library. This method allows users to securely give access to the web page. **Unfortunately, because of time constraints we were unable to implement predefined questions for the Hi-Fi prototype.**

#### QR scanning

As mentioned before, the QR scanning functionality is added on the home page. This allows users to scan the code next to the painting and immediately start chatting about it with the bot. It is implemented using the ZXing library for processing scanned QR codes. According to previous user studies, this is a more convenient way for users to quickly get the desired information about an art piece.

The user's camera serves as smart hardware for intelligent interaction by capturing the QR code via real-time video. Then the QR code is given to the ZXing library to process it. This service allows to save time for the user as it directly gives the information to the chatbot instead of searching through the database of available paintings.

## Chatbot implementation

The chatbot is implemented by using a static, human curated knowledgebase, and an LLM(large language model) to interpret the request of the user and retrieve the correct information. We implemented the LLM through Ollama, which is a software system that allows users to run LLM's locally, yet Ollama itself cannot do anything without a model, as it is only a container for loading models. In our application, we use Llama 3.2 8B.

Since LLM's are prone to hallucination, as they always tend to answer questions, regardless of if they know the answer. We only use the LLM to interpret the users request and have it find the factual information from an information sheet written up by the museum.

Since the museum presumably has access to a lot of information and fun facts about any painting or artwork, it would be overwhelming to hand it all to the user. However the LLM can pick specific facts from this information and answer user questions concerning that artwork. It will give the user the specific piece of knowledge they are looking for, while staying factual. This approach can be improved significantly to gain extra reliability and accuracy by the following means:

Firstly, currently the model runs on a mid to high end laptop, if the museum possesses a server, or is willing to pay for hosting, a significantly larger model can be used to increase reliability.

Then, there is the option to switch to a better model, Deepseek has been released for less than a month as of writing, assuming it proves to be reliable, it has better benchmarks, hence Llama3.2 can be swapped out for it. So long as the models being swapped are general purpose text models, they can be swapped with minimal modifications to the system. This also scales towards the future, as so far, models keep improving, even when using the same amount of resources.

Second to last, our implementation relies on adding text to the user prompt, while functional, this can be unreliable, and is prone to user manipulation, especially if they are intentionally trying to manipulate the LLM. To cover this, system prompts can be used, which means the user has a harder time manipulating the LLM.

Finally, an LLM can be retrained to specialise in its task. This is far outside the scope of this project, however if Art2D2 were to be implemented on a large scale, making a specially trained LLM could ensure that the LLM is better at picking out information and admitting when there is a gap in this information.

## Model choice

There are over a hundred LLM's available to be run in Ollama. To pick a good model, we decided that a model needed to have a proven track record, be open model weights and have a size available for devices with small amounts of processing power.

Llama3.2 is based on Llama3, being an open-weights model developed by Meta. The model has been released for 9 months, and is generally considered the default, proving its reliability. There are many variants and retrained versions of Llama (and other models, like Minstrel) however these different versions often have a focus, the most common ones being specialization in a field (coding) or adherence to a character. Since we could not find a version specific to our use case and the process of retraining a model also has a cost on its other functions, the original model was the best for our use case.

Having decided upon Llama, there are three versions, 3.1-3.3. More important than the version number is the amount of parameters though. As generally, the "true" model is extremely large (405 billion parameters). To be able to run a model, you generally need (Amount of parameters in billions) X 1.2 in GB of RAM. Since a normal computer has between 4-16, running Llama 405B is not viable for us.

Luckily models also have "distilled" versions. Models of a smaller size based on the original, aiming to keep as much of its functionality. The original Llama3.1 has sizes 8B and 70B available. Of these, the 8B model can be run on some of the higher end devices in the possession of our group.

Llama3.2 does not provide an increase in quality, 3.2 is the designation of 1B and 3B distillations of the original model. We decided to swap over to 3.2 because it means that even the weakest laptop we had could run the model, and thus host the website. If our project were to be scaled up, a larger model would be preferable.

For example, Llama 3.3 is a 70B model that has comparable performance to the 405B original model, thus, assuming we do not train our own model, or change architecture, it would be the easiest way to improve the reliability with no side effects or labour.

## DeepSeek

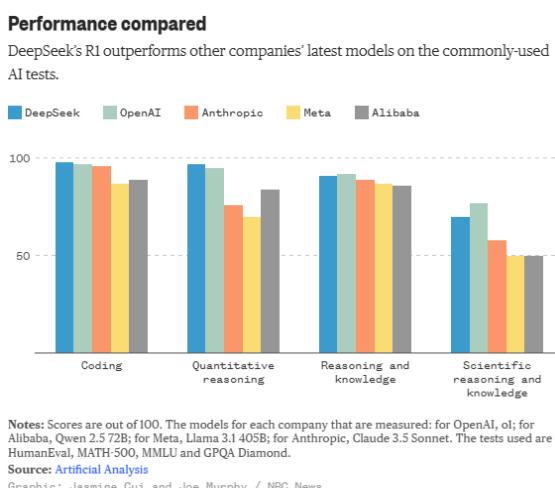


Figure 5.5

## Latency

Seconds to First Token Received; Lower is better

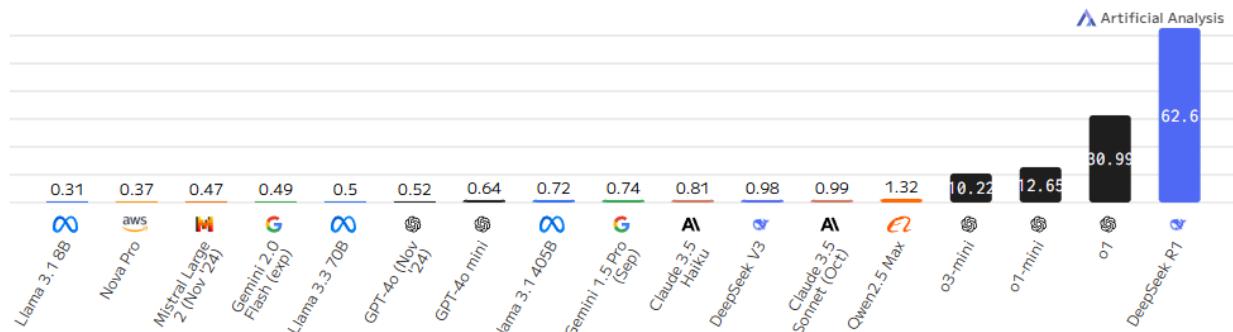


Figure 5.6

During development, Deepseek was released, a revolutionary model that has significantly better output, comparable to the best closed source models available (Cui & Yang, 2025)(Figure 5.5). (Deepseek is dark blue, Llama3 is yellow) This comparison is made using the largest models of each competitor, however their relative strength should stay the same if the downscaled models are used.

Seeing this, it would seem wise to switch to DeepSeek instead of Llama, however, there are multiple performance and architecture concerns.

First off, Llama has already been proven to work, it seems to respond well to the way we prompt it. Using deepseek could have an unpredictable effect on the reliability of our prompts. Thus, it would need significant adjustment, unlike other versions of the same model.

A more significant problem than needing to rewrite prompts is the way in which deepseek generates answers. In order to be more accurate, deepseek first re-words and analyzes the information it has in a thinking block, and then formulates an answer. While more reliable, this also takes extra time (Artificial Analysis, 2025)(Figure 5.6). Thus answers can take anywhere from 2-10 times as long, especially if the response is shot (like in our use case).

Since it is important for our use case to have quick responses in combination with model accuracy being less relevant since it can rely on a provided knowledge base. Switching to Deepseek would be a mistake, since it would be a minimal reliability improvement at a significant usability (speed) cost.

### 5.2.3 - Study Protocol for the Small-scale User Test

#### Objective:

Evaluate the effectiveness and usability of our prototype for an LLM museum guide.

#### Study setup and environment:

This study will be conducted in a silent room in the library. The participant will have several QR codes next to specific paintings to choose from.

**Materials:**

1. Smartphone with internet access for each participant.
2. Printed QR codes each linked to a specific painting in the prototype.
3. Notebooks or digital devices for the observer and data recorder.

**Participants:**

6 participants representing museum visitors, who should be comfortable using smartphones and interacting with digital tools.

**Roles in the team:**

Facilitator: Talks with and guides the participants

Observer: takes notes and observations about participants

DataRecorder: centralises and organises measures

**Procedure:**

The participant will be presented with a few paintings with QR codes placed next to them. They will be free to scan a code of their choice on their phone which will take them to the museum website and they will be able to communicate with the museum system with questions regarding the painting.

**Step-by-Step Procedure:**

1. Welcome and Introduction
  - a. Greet the participant and thank them for their time.
  - b. Briefly explain the purpose of the study and the application
  - c. Outline what the participant will do
  - d. Reassure participants about confidentiality
2. Pre-Test Questions
  - a. Ask a few pre-test questions to understand the participant's familiarity with museums and technology
3. Task 1: QR Code Scanning and Initial Interaction
  - a. Provide the participant with a QR code to enter the web application.
    - i. Say: "Please scan the QR code with your phone. It will take you to the museum website, where you can interact with the system."
  - b. Provide the participant with a painting and a QR code next to it.
    - i. Say: "Please scan the QR code with your phone. It will take you to the chatbot page, where you can have a conversation with the bot about the chosen painting."
  - c. Observe whether the participant can successfully scan the code and access the website and the chatbot page. Note any errors.
4. Task 2: Asking the Chatbot Questions
  - a. Instruct the participant:

- i. "Now, use the chatbot to ask any questions you have about the painting. You can ask about the artist, the historical context, or anything else that comes to mind."
  - b. Let them explore the chatbot but intervene if the participant seems stuck.
  - c. Record:
    - i. Time taken to complete the task.
    - ii. Whether the chatbot provided accurate and relevant responses.
    - iii. User reactions.
5. Task 3: Personalized Quiz
- a. Direct the participant to the quiz feature:
    - i. "You can now take a short quiz about the painting. The chatbot will guide you through it."
  - b. Observe
  - c. Ease of accessing the quiz.
  - d. Engagement during the quiz (e.g., interest level, hesitation).
  - e. Accuracy of responses and chatbot feedback.
6. Task 3: Searching the database
- a. Instruct the participant:
    - i. "Now, use the database to search for any painting you want to ask questions about. You can use the provided filters to help your search."
  - b. Let them explore the chatbot independently but intervene if they seem stuck.
7. Post-Test Feedback
- a. Ask participants to complete a post-task survey, including:
    - i. Open-ended questions, e.g.:
      - 1. "What would you add/remove to/from the system?"
      - 2. "Anything you liked/would improve on?"
      - 3. "What did you think about the UI?"
      - 4. "Was the application easy to navigate?"
  - b. Conduct a brief verbal interview if needed:
    - i. "Any Comments?", and communicate any other questions based on the flow of the conversation

## **Results:**

- Quantitative Metrics:
  - Time: how much it took to complete a task
  - Error number: how many errors per task
  - Success rate: how many users finished the task / all users
- Qualitative Metrics:
  - Post-Interview questions
  - Userfeedback after completing a task
  - Observations about user behavior

## 5.3 Results

Performance data represents Quantitative Metrics of the results, while Thematic analysis represents the Qualitative Metrics that was collected from the interviews.

### 5.3.1 Performance Data

Performance data shows the places of strengths, weaknesses and improvement points for the research in a quantifiable manner. For this stage of the research, we decided to keep track of error rate, time of completion of the task, and the overall success rate for each task. The error rate provides insight on whether something is a design flaw or the user error, and helps to better adjust in the next stages of the development. Time of completion, shows potential or present bottlenecks of the design and implementation. Success rate portrays whether in the end the intended goals were achieved by users, and shows possible points that need design adjustments. The data was collected during the application use part of the interview. For error rate we were looking for any potential mistakes either on the user or the application side, so if something went wrong, it would be recorded, the time was recorded using the stopwatch, and success rate was based on whether the user got to the end of the intended task. For example, if the person after scanning the QR code(suppose this task was complete), asked a question on the chatbot page, and received an answer, then we count it as the successful interaction for the chatbot interactions task.

1. Error rate
  - a. Scanning QR codes: 2/6. However, the technical difficulties were created by the application itself.
  - b. Chatbot interactions: 0/6 participants completed a question-answer interaction
  - c. Quiz: 0/6 participants accessed the quiz.
2. Time needed for task completion
  - a. Scanning QR codes: on average took around 10 seconds if both the website homepage, and painting scanning were accessed.
  - b. Chatbot interactions: on average 15-30 seconds, as the processing of the queries and generating the answers were happening at a slow rate.
3. Success rate
  - a. Scanning QR codes: 6/6 participants successfully scanned codes without assistance (100% success rate).
  - b. Chatbot interactions: 6/6 participants completed a question-answer interaction (100% success rate).
  - c. Quiz: 6/6 participants accessed the quiz (100% success rate).

### 5.3.2 Thematic analysis

For the thematic analysis, the themes were created based on the popularity of the opinion. In other words, if similar ideas were presented by 3 or more participants, we took it into consideration. I was chosen to be 3 or more, as the total number of participants was 6. After analysing the user studies, we identified the following themes: Ease of page Navigation and Layout, Database Functionality, Engagement with the Quiz, Ease of scanning method, Chatbot interaction.

#### 1. Ease of page Navigation and Layout

Most participants found the application easy to navigate, and appreciated the ease of user-interaction flow as well. "Extremely easy to navigate", "Navigation is easy, not too complicated. It is intuitive, you know what each click does"(more) However, users mentioned that the homepage required scrolling and had small buttons, making some features less accessible. "Make the buttons on the front page much bigger."

Additionally, the brand-consistency was suggested, and the name "Art2D2" was applied, but not throughout the application. "Art2D2 everywhere, instead of Art Gallery in db"

#### 2. Database Functionality

Participants found it easy and useful to have the database and filtering system inside. "Then the db functionality, used the filters a little bit and thought it was nice", "Thought the DB was very cool.", "Asked about how the sorting features were thought out and made, liked the thought behind it." . One of the participants offered to remove the country filter: "doesn't really like the country filter, doesn't think it's useful", and the other one offered to add the painting codes filter. " He would add codes as a search filter, so like individual painting codes that you can search by".

#### 3. Engagement with the Quiz

Participants enjoyed the quiz option: "the quiz is fun.", " liked the overall quiz". However, the suggestions to adjust the quiz for the phone version as well were made. Additionally, the suggestion of more tries to answer the question was made. "Made a comment about saying "try again" instead of answering right away." Regarding the difficulty level, no participants commented on it, hence, it could mean that the questions were on an acceptable difficulty level. For future studies it should be asked directly.

#### 4. Ease of scanning method (QR)

Overall the "QR code was scanned with ease" for 4 out of 6 participants. There were 2 technical issues for 2 other participants. Firstly, one of the participants scanned the QR code and received a notification that it was invalid "trouble with the QR code on our part (the QR code expired)". As it was the issue on the team's part, the new code was created to get access to a homepage of the application. Secondly, One of the participants used Safari browser to view the application, but the issue with scanning arised, hence, the participant was asked to switch to a different browser. "Went to try the

scanner, apparently it doesn't work with safari, so switched to Chrome." Both issues were either mitigated or solved.

##### 5. Chatbot interaction

The chatbot itself received positive feedback. "The chat is good", "The chat is fun". One of the participants mentioned that they like that you can ask chatbot any question "You can ask any question about the painting which is nice". Each participant asked at least 1 question, and one participant asked more."Asked another question." Besides, for each participant the model was outputting the answers at a slow rate "in about 7 seconds got an answer back", "in about 10 seconds got back the answer", so one participant made a suggestion to create a "generating..." bubble, so the users are aware that they need to wait. "IDEA: put "generating..." chat box while generating quiz/answers"

## 5.4 Reflection and iteration

The findings from the user interviews were helpful to realise the advantages and disadvantages at this stage of development.

During the interview phase, the participants were able to use and navigate the application mostly themselves. Hence, the flow of the application is easy to use and the buttons and links are self explanatory. However, during the post-interview questions phase more questions could have been asked directly, to collect more feedback on the designed hi-fi prototype.

For the next stages of development a few features should be adjusted or implemented, such as making sure the layout and the buttons are easier to use on the smartphone version of the app, improving the response time of the model, adding codes to the paintings to find them easier in the database. **Additionally, implementing the feature that was not implemented and shown in the hi-fi prototype due to time constraint - suggested questions when the user enters the chatbot page after choosing the painting.**

## Answering the research questions

### RQ1: Do users understand all the features of the product from the first page?

Participants found the navigation to be easy, however, some buttons and layout were not as easy to use when participants were using smartphones to access the website. Two suggestions were made: to increase the size of buttons that lead to other pages on the homepage, and change the layout of the home page as on the phone there was too much text to scroll to get to the buttons.

**Answer:** The participants were able to understand all features from the homepage as all participants tried out the chatbot and database pages.

### RQ2: Are the ways of choosing a painting easy to navigate?

Participants utilized both of the methods during the interviews, and were easy to navigate and use to choose the desired art piece. There were minor issues that arose during the interview, but were solved quickly.

**Answer:** The ways of choosing the painting were easy to navigate and use, and felt intuitive for the participants. Both methods were tested by each participant, and were easy to use for the participants.

**Sub RQ1:** Does scanning the QR code feel intuitive?

Participants mainly found it easy to utilize the QR codes. There were 2 technical issues with different participants. One of the participants scanned an invalid QR code, as it was the issue on the team's part, we quickly generated new code for accessing the web application. Another participant used Safari browser to view the application, but the issue with scanning arised, hence, the participant was asked to switch to a different browser. Both issues were either mitigated or solved. Other participants did not encounter any issues.

**Answer:** The QR scanning felt intuitive for the participants, however a few adjustments should be made to work with different browsers, and renewing the code on time.

**Sub RQ2:** Does the filtering feature of the database make it easier to explore?

The participants enjoyed the filtering feature of the database, as it helps to find the desired piece in a more convenient way, and filtering categories were mainly approved. One participant suggested removing filter category : country, as it seemed unnecessary for the database filtering system. Additionally, the other participant offered to add the painting codes filter to find the paintings easier, if you do not know the name, country, etc.

**Answer:** designed filtering system enhances the exploration experience about the art pieces.

**RQ3: How can we incorporate the quiz?**

The implementation of the quiz was decided to be integrated in the chat, and the feedback regarding this was collected.

**Answer:** The quiz implementation in the chat was found engaging by the participants. Additional tries fr answers could be beneficial, as well as, the implementation of the quiz for the smartphone version.

**Sub RQ1:** Do users like the quiz within the chat conversation?

The participants found the quiz that is incorporated into the chat engaging. However, as the implementation was available only on the laptop, the users would like for it also to be implemented in the smartphone version.

**Answer:** Users enjoyed the quiz, however, the implementation of this functionality on the smartphone version could help with increasing the engagement more.

**Sub RQ2:** How difficult should the questions be?

The participants liked the questions that were suggested, and did not find them too hard or too easy. Future study should explicitly ask to evaluate the difficulty level. One participant mentioned that when the user answers the question incorrectly, then more attempts should be offered.

**Answer:** The participants did not find questions too hard or too easy, however, future testing should implement this question directly during or after the interview.

**RQ4: Does the conversation with the chatbot feel personalized?**

The participants were overall satisfied with the chatbot. Besides, some participants asked more than one question, which clarified the information that they wanted to know. One of the issues that arose during each interview, the answers were outputted slowly, so the suggestion of the pop-up “generating...” was made.

**Answer:** the participants found the answers fitting to their taste, and if something was unclear participants asked more questions to the model to get a more personalised and elaborate answer.

**RQ5: Would a user prefer our product over traditional ways of researching?**

The participants overall like the app, the idea behind it, and the way it was implemented. A few suggestions were made to improve the ease of navigation or flow. However, in future studies the question should be asked directly during or after the interview.

**Answer:** The participants overall like the app, the idea behind it, and the way it was implemented.

# Chapter 6 - Design of Large-scale User Experiment

To further evaluate how to best implement our solution to help customization in a museum environment, it could be helpful to perform large-scale user experiments. Most importantly, the exact form our system takes and what features are the most desirable and in need of refinement (Overview, Quiz, Comparison). In comparison to which features could be considered bloat/unecessary. To test if our system actually supports museum users with personalized learning, we suggest further testing.

## 6.1 Research goal

The main question of our research is: "What effect does a personalized chatbot answering visitor questions have compared to traditional museum plaques providing generic information texts on user engagement and perception of relevance?".

Our independent variables are what sets of features are provided to subjects. Theoretically, we could also vary the artworks displayed, however these are kept the same for all groups, to make sure that what art is shown does not affect the outcome. Similarly, the museum should also be kept the same.

Our dependent variables are how visitors react to the changing independent variables. Most notably, how much personalization they perceive, what fraction of information they found useful, and how much time they spent inside of the museum.

The best way to determine this would be to test multiple groups, providing each group a different combination of available features (one with none altogether as a baseline). During the test, response time and quiz results (if available) will be measured. However, more importantly, a questionnaire will be conducted after the test, where we will evaluate how visitors perceive the technology and their learning opportunity.

## 6.2 Methods and materials

### **Conditions:**

Our experiment will have two conditions: using our chatbot implementation to get information about paintings and using a normal text plaque. The two groups will have similar experiences, the only difference being one gets presented with a pre-written chunk of text about a painting, similar to what one would find in a museum, and the other group will be given our tool that they can use to get their information.

### **Target user group:**

Our target user group is museum visitors. To be more specific, museum visitors who are interested in the collection that has been prepared for the test. The preferred sample size is around two hundred people. Although more is preferable, having 200 comparisons would be likely to generate statistically significant results, as with 100 users per group, we can get a very small error margin.

**Independent Variable:**

The Independent variable is regarding the information delivery method. There are two versions. The first version is a personalized chatbot where visitors can ask questions and receive personalized and tailored responses. The second version is generic text plaques displayed next to the artworks.

**Dependent Variables:**

Perception of Relevance: A post-interaction survey asking visitors how relevant they found the information on a scale of 1-5 (Linkert scale).

User engagement: This is measured by recording the time the user spends interacting with the exhibits which is comparing time spent reading the plaques and time spent asking the chatbot questions. It can also be measured by recording the number of questions asked by the user when interacting with the chatbot.

**Statistical Tests:** The statistical technique that can be used for this is the independent samples t-test where we are comparing the means of two dependent variables (relevance score and engagement time) between two independent groups. This is because we have two groups that are independent of each other to whom we are giving the different products to test on as given by the between-participant design.

Relevance score: To compare the average relevance score between plaque and chatbot conditions. The null hypothesis is that there is no difference in relevance score between plaque and chatbot conditions while The alternative hypothesis is that the mean relevance score for chatbot conditions is greater than that of the plaques condition. The same method for relevance score can be done for the engagement time.

# Chapter 7 - General Discussion

## 7.1 Problem statement

Our problem statement asks us to allow for more personalization inside of a museum environment. While this is a goal to strive towards, there is no such thing as a perfect amount of interaction, only an improvement. Our solution does greatly improve customizability compared to the baseline (scannable QR codes leading to a static page), and thus it can be considered a success.

Another more modern solution to compare it too is an augmented reality tour. While the AR approach changes the presentation, it does require additional hardware, in addition to being a set format and sometimes detracting from art, especially if the art was not made with AR in mind (like most works). To this end, our solution achieves its goal while minimally detracting from the pieces themselves.

The most notable innovation is that instead of handing all information regarding a work of art to the visitor, our solution allows for the user to receive specific customized information they request. This way, they can learn more about topics that interest them.

## 7.2 Concept and prototype

We originally made a low-fi prototype to be able to interview users on the UI and site navigation. While this resulted in some useful data and feedback, it was difficult to properly wizard the underlying system with minimal prototyping. The low-fi prototype was useful to some extent, since it informed how to design the layout of the hi-fi prototype, however it had minimal use for testing the viability of our core concept. The high-fi prototype, on the other hand, has its functionality expanded to be close to the full end product, with the presentation saying the same.

It contains a lot of features that are implementations of already existing technology or protocol. The upside of this is that this makes it more customizable, as different uses can rely on the core functionality of providing information in differing ways. Things that can still be improved are most easily found in the out of the box solutions used or the data provided:

- The system uses an LLM model to interpret questions and find information, this can be improved in three different ways, each more resource intensive than the last:

First off, it is possible to simply apply a more powerful model, the current model used is Llama3.2 8b. Using a more specialised model, a larger model or a model that performs better (as this field improves over time) would make our solution more consistent. This improvement has the lowest cost, as LLM models are easily swapped.

- A more advanced upgrade to the LLM system is also possible, our presentation version of the product does not use system prompts or retraining. Even after picking a model, it can be better fitted to the question-lookup structure that is part of our Art2D2.

- Another important factor is the knowledge known about the artworks, since this database provides the knowledge (to counteract the volatility of LLM systems), making sure this database contains all relevant information of all artworks displayed could greatly increase the accuracy of our system.

- Additionally, we have implemented three features we have previously mentioned, but were not yet ready for the Hi-Fi prototype: the UI has changed to have a more consistent look over the whole website, the quiz was fine-tuned to be generated by the AI model, by keeping track of the visited paintings for each visitor in the web application session and later requesting the Ollama model to create the multiple choice quiz focused on these specific art pieces, and also works on mobile now. Besides, the predefined questions have also been implemented, so users can click on one of two questions to start a conversation.

The most important thing we learned about our problem is that determining what is personalization, and more importantly, desirable personalization is very difficult. Not only does it differ from person to person. However making sure that it is usable can also be quite the challenge.

When it concerns our concept, one of the challenges was pinning down exactly what we were making. The base concept of our solution was using an LLM to select true information from a curated database based on user request. This can take many forms though, from a quiz to the user asking questions. This meant that talking about details was difficult sometimes.

When it concerned doing research, user interviews gave the most insight in where to go of all testing methodologies. Originally, we had ideas of routing systems. However visitors expressed that they prefer to go their own way, only calling upon additional assistance when they have questions or a need for it. Especially when it concerns leisure activities.

If we were to do the prototypes over, we would start the lo-fi prototype with a focus on the core functionality, instead of the presentation. When it concerns our hi-fi prototype, it was less focused than we had originally planned, and if we were to redo it starting from the functionality instead of the presentation, it would have a more focused result.

Our low-fi prototype would take the form of a less visually impressive version of a chat, probably by using an existing chat implementation, and wizarding the “AI” by having a team member send the proper response by hand.

This would lead into a focus on the core principles, like what should be in a quiz, and the unique challenges that originate from our concept. Opposed to our current prototype that focused on layout and known UI refinement. If we would have had the research on how such a system should act, we could further refine this in our high-fi prototype (for example, the tone of the response could be professional or casual, which is better).

To turn this into a minimal viable product requires minimal changes, as it currently is quite flexible, thanks to the LLM interpretation. The biggest current limitation is scale and implementation.

To make this a minimal viable product, the following things need to be changed:

Add a database for a real museum: Currently the information provided is only for 3 paintings, and only a minimal amount. To make it fully functional, the amount of artworks Art2D2 has data

on needs to be increased, together with the amount of data.  
Redo the code so it is scalable: This includes the ability to accept connections more smoothly, host QR-codes without relying on a site that only allows use for a few hours at a time, making a proper database to manage the artwork entries instead of hard coding them, etc.  
Upgrade the LLM: Currently we use an LLM that is small, relatively speaking, if we need to deliver a product, then it needs to be more reliable, to this end, using a larger model is possible.

## 7.3 Ethical considerations

Assuming Art2D2 gets mass adoption, there are a number of factors to consider regarding ethical considerations.

First among those is the possibility of misinformation. Museums are often regarded as an official source of information, especially regarding art. Since our system uses LLM's, which are generally considered volatile and unreliable, it could wrongly inform users. This is mostly counteracted however by relying on a human curated database of artwork information. Thus making sure that the facts provided are accurate. There are still risks of information being worded differently in ways that change its meaning, and thus this risk cannot be fully covered. Like most data based solutions, a large database is needed and this brings concerns about the ethics of constructing said data and the safekeeping of user data. When it concerns the creation of a database for our system, it only requires information about the artworks, which should already be available to the museum who displays the artworks. Since no user data storage is required for the system to work, third party data collection is of minimal concern (as long as the LLM systems are run locally / have a policy to not use user data).

The final concern is that currently it is quite easy to make Art2D2 respond in a non-helpful, funny and potentially even problematic way. This behavior only takes place when provoked by the user however, and since there is no user to user interaction within the system, this behaviour is generally harmless, if unprofessional.

Another concern is inaccessibility. Since our solution is text based, it is unlikely to be of much help to visitors with a vision impairment. A major accessibility option could be audio support. While this has been considered, we deemed it too disruptive to implement. Since Art2D2 runs on phones, it would use phone audio. Which by default originates from the phone and would disrupt the museum and distract other visitors. For this reason, audio support was cancelled.

## 7.4 Reflection on stakeholders

Our product increases personalization, however it might not work for every person.  
For museum visitors in general, it can be a helpful tool, however to determine if it works for every stakeholder, we will need to look into specific stakeholders:  
Visitors who dislike large groups: Since they can use our implementation instead of a tour guide, this group has a use for our solution.  
Parents with inquisitive kids: Since we needed to drop the customizability to prevent scope creep, the answers are often quite formal and can use complicated words. In addition our implementation might refuse to explain terms, unless the terms are in the knowledge base.

While it could work for older children who have the knowledge to make sense of the answers. Our solution minimally assists young children.

Students who want to deepen their knowledge: Our solution should have the full museum database on an art work. And thus be able to give specific new information that these students ask for, therefore, our implementation would be of use to this group of stakeholders.

Tech geeks: Our solution is a technical one. The full version presumably includes an explanation in the about page. While our implementation in itself is not a reason to go to a museum.

Messing with an AI-powered system is an activity tech geeks are interested in (Heijmans, 2025). People who are interested in a specific topic: Since our solution can filter out all knowledge about an artwork that the person is interested in and provide only that. Our solution can help this group.

In general, the needs of most of our stakeholders are met. Measuring exact success is difficult, since we have not been able to perform a test using the high-fi prototype with statistically significant group sizes for each stakeholder. Thus, the ability for our solution to meet stakeholder demands is theoretical.

## 7.5 Reflection on process

Looking back on the process during this module, one of the biggest challenges for most of us was punctuality. Over half of us were regularly late to meetings and practicals.

Another challenge was coherence of writing. We often split up sections of reports and tasks, and later combine them which was difficult with clashing writing styles and structures. The advantage of this task splitting methodology was that it was productive, and allowed for easy reallocation of work, tracking what had been done and keeping people accountable.

When it concerns the project itself, we often encounter overlapping skill sets, or overlapping gaps in our skills since all of us have a very similar expertise. This was most noticeable with the interviews and gaining understanding of the exercise, which was difficult.

On the upside however, when we started on the high-fi prototype, after some initial confusion about what systems to use, it came together smoothly.

# References

Fogli, D., & Arenghi, A. (2018). "Design for all" versus "one-size-fits-all": The case of cultural heritage. In Proceedings of the CEUR Workshop Proceedings (Vol. 2101, pp. 89–96). Ceske Budejovice, Czech Republic. -> [link](#)

Bowen, J., & Filippini-Fantoni, S. (2004). Personalization and the web from a museum perspective. Proceedings of Museums and the Web 2004 Conference. Archives & Museum Informatics. -> [link](#)

Solima, L., & Izzo, F. (2017). QR Codes in cultural heritage tourism: new communications technologies and future prospects in Naples and Warsaw. *Journal of Heritage Tourism*, 13(2), 115–127. -> [link](#)

J. Lackey, S. Borkin, V. Torti, T. Welnetz, D. Moberg (2010). Behind the Findings: Yes, the Science Exploration Program Worked, but Why? *The Museum Journal*, Volume 50 Issue 3, p319-340.

<https://onlinelibrary.wiley.com/doi/abs/10.1111/j.2151-6952.2007.tb00275.x>

Charr M. (2024, April 10). How Museums are using Augmented Reality. *MuseumNext*.  
<https://www.museumnext.com/article/how-museums-are-using-augmented-reality/>

Anne Frank House, 3D virtual tour. Retrieved November 15 2024  
<https://www.annefrank.org/en/museum/web-and-digital/>

Straughan C. (2019, September 4). The Changing Face of Museum Tours. *MuseumNext*.  
<https://www.museumnext.com/article/the-changing-face-of-museum-tours/>

[Virtual Reality in Museums: Exploring the Experiences of Museum Professionals](#)  
Shehade, M., Stylianou Lambert, T. (2020, June 11). Virtual Reality in Museums: Exploring the Experiences of Museum Professionals. MDPI Open Access Journals,  
<https://doi.org/10.3390/app10114031>

[Concerns and Challenges Developing Mobile Augmented Reality Experiences for Museum Exhibitions](#)

Marques, D., Costello, R. (2018, December 06). Concerns and Challenges Developing Mobile Augmented Reality Experiences for Museum Exhibitions. Wiley online Library,  
<https://doi.org/10.1111/cura.12279>

[5] Dressel, B., (2024, June 13). Museum Technology: 7 Examples of Next-Gen Exhibition Design. *BridgeWater Studio*.

<https://www.bridgewaterstudio.net/blog/museum-technology-7-examples-of-next-gen-design>

Ma, X. (2021, June 29). Touchless Technologies for Museum Engagement. *Arts Management & Technology Laboratory*.

<https://amt-lab.org/blog/2021/6/touchless-technologies-museum-engagement>

Madsen, K. (2020). The Gamified Museum: A Critical Review and Discussion of Gamification in Museums. ResearchGate.

[https://www.researchgate.net/publication/327860304\\_The\\_Gamified\\_Museum\\_-\\_A\\_critical\\_literature\\_review\\_and\\_discussion\\_of\\_gamification\\_in\\_museums](https://www.researchgate.net/publication/327860304_The_Gamified_Museum_-_A_critical_literature_review_and_discussion_of_gamification_in_museums)

Ćosović, M. and Brkić, B. (2020). Game-Based Learning in Museums-Cultural Heritage Applications. *MDPI Open Access Journals*.

<https://doi.org/10.3390/info11010022>

MuseumNext. (2023, December 26). *The disadvantages of using virtual reality in museums*. MuseumNext.

<https://www.museumnext.com/article/the-disadvantages-of-using-virtual-reality-in-museums/>

Niu, H. (2023). The effect of intelligent tour guide system based on attraction positioning and recommendation to improve the experience of tourists visiting scenic spots. *Intelligent Systems with Applications*, 19. <https://doi.org/10.1016/j.iswa.2023.200263>

<https://www.pewresearch.org/short-reads/2022/01/13/share-of-those-65-and-older-who-are-tech-users-has-grown-in-the-past-decade/>

Faverio, M. (2022, January 13). *Share of those 65 and older who are tech users has grown in the past decade*. Pew Research Center.

<https://www.pewresearch.org/short-reads/2022/01/13/share-of-those-65-and-older-who-are-tech-users-has-grown-in-the-past-decade/>

Digitale, E. (2022, November 21). *Age that kids acquire mobile phones not linked to well-being, says Stanford Medicine study*. News Center; Stanford Medicine.

<https://med.stanford.edu/news/all-news/2022/11/children-mobile-phone-age.html>

Pechenizkiy, M., & Calders, T. (2007). A framework for guiding the museum tour personalization. <https://mpechen.win.tue.nl/publications/pubs/PechenizkiyPATCH07.pdf>

Wu, J., Hei, Y., Fan, Y., & Zhou, X. (2023). An analysis of the requirements for smart guiding services in museums using the Kano-AHP method. *Journal of Artificial Intelligence Practice*, 6(4). [https://www.claudiuspress.com/assets/default/article/2023/06/25/article\\_1687708208.pdf](https://www.claudiuspress.com/assets/default/article/2023/06/25/article_1687708208.pdf)

Wu, J. et al (2023). An Analysis of the Requirements for Smart Guiding Services in Museums Using Kano-AHP Method. *Claudius Scientific Press*.

<https://dx.doi.org/10.23977/jaip.2023.060407>

Pechenizkiy, M. (2007). A Framework for Guiding the Museum Tours Personalization. *Eindhoven University of Technology*.

<https://research.tue.nl/en/publications/a-framework-for-guiding-the-museum-tour-personalization>

Artificial Analysis. (2025, February 2). *Comparison of AI models across quality, performance, Price*: Artificial Analysis. Comparison of AI Models across Quality, Performance, Price | Artificial Analysis.

[https://artificialanalysis.ai/models?models\\_selected=o1%2Cgpt-4o%2Cllama-3-1-instruct-405b%2Cgemini-1-5-pro%2Ccclaude-35-sonnet%2Cmistral-large-2%2Cqrok-beta%2Cdeepseek-r1%2Cdeepseek-v3%2Cqwen2-5-72b-instruct%2Cyi-large](https://artificialanalysis.ai/models?models_selected=o1%2Cgpt-4o%2Cllama-3-1-instruct-405b%2Cgemini-1-5-pro%2Ccclaude-35-sonnet%2Cmistral-large-2%2Cqrok-beta%2Cdeepseek-r1%2Cdeepseek-v3%2Cqwen2-5-72b-instruct%2Cyi-large)

Cui, J., & Yang, A. (2025, January 28). *How DeepSeek stacks up against popular AI models, in three charts*. NBCNews.com.

<https://www.nbcnews.com/data-graphics/deepseek-ai-comparison-openai-chatgpt-google-gemini-meta-llama-rcna189568>

According to T. Heijmans (2025, February 2), “I really like seeing how LLM’s work, especially if they have a unique implementation for me to try with some documentation”

# Appendix

## Appendix 1: Personas & References



**Name: Erik Smith**  
Relevant Quote: "I want to enjoy a calm museum visit without needing to be a walking encyclopedia"

Demographics	
Gender:	Male
Age:	42
Location:	Rotterdam
Relationship Status:	Married
Title:	Senior database manager
Education:	VWO

**Goals**

- Get the most relaxation from a weekend off
- Make sure his children, Erik JR. and Sofia are happy.
- Not anger his wife, Henrik

**Background Description**

Erik is a 42 year old married man with an office job and 2 children. He likes to visit museums from time to time as a family activity. While visiting a museum, Erik values clear and abundant information, so he can answer all the questions his kids ask and look smart in front of his wife.

Motivations	Frustrations
<ul style="list-style-type: none"><li>Appear intellectual</li><li>Entertain his kids</li><li>Have a calm weekend</li></ul>	<ul style="list-style-type: none"><li>Museums often don't provide enough info to answer his children's questions.</li><li>Tour guides are too slow, boring his children.</li><li>Many museums present the information without a story or interesting flair.</li></ul>

**Previous Experience:**

While the environment is calm the amount of improv and reading needed to keep a museum interesting for young kids is difficult. Apart from this, Erik takes great joy in discussing art details with his wife.

**Expectations:**

- The solution will help him answer the questions of his children while still allowing for conversation
- The technology is accurate, safe and produces only factually correct information



## Name: Luciano Castanni

Relevant Quote: "Modern ways of exploring the past excite me!"

### Demographics

Gender:	Male
Age:	31
Location:	Milan, Italy
Relationship Status:	Single
Title:	Electronic Engineer
Education:	Eindhoven University of Technology

### Goals

- Encourage Interaction with the exhibits
- Encourage Lifelong Learning
- Blending traditional museum elements with futuristic tools

### Background Description

Luciano is a 31-year-old electronic engineer, who lives in London. He is a bachelor and is very passionate about technology, so much he pursued a career in electronic engineering. He's particularly interested in how devices facilitate processes or make a digital process more immersive work. He is always up to date with the newest devices and equipment. He likes going to museums, but he does it more to see how museums integrated technologies in their tours. He also enjoys exhibitions about the evolution of human tools, from rocks and spears to computers.

### Motivations

- Expanding his knowledge about certain subjects.
- Finding new ways to explore a museum.
- Seeking a new immersive experience of learning.
- Inspiration for his implementations.

### Frustrations

- Tour guides move on too soon and he doesn't have time to fully understand the concept.
- He finds classic tours boring.
- The lack of interactivity.
- Complex setups or poorly designed technologies might be over-complicated.

### Previous Experience:

- Goes frequently to expositions.
- Participates in Roman Empire conventions.
- Reads history related books whenever he can.

### Expectations:

- Easy to understand solutions that would make his kids more interested.
- The possibility of touring without a guide and learn even more facts.
- Technology shouldn't be flashy, but deliver value, like information or immersive story telling about the exhibits.



## Name: David Jansen

Relevant Quote: "I want to make museums more interesting to go to"

### Demographics

Gender:	Male
Age:	34
Location:	Apeldoorn
Relationship Status:	Single
Title:	Museum curator
Education:	Design degree

### Goals

- Wants to make a successful museum exhibit
- Hopes to be an artist one day

### Background Description

David liked art, however he ended up in design to get a stable job. He currently works for an modern arts museum. The biggest part of which is designing and placing museum artworks, and determining how they fit in the museums current offerings. An example of what David does is determining how the audio tour needs to be adjusted when new pieces come in.

### Motivations

- Wants to make art the best it can be
- He gets paid for this (its his job)
- Likes to write about art.

### Frustrations

- Not everything about an art piece can be added as context
- Sometimes, a different composition or way of delivering information works better but only for a small group of people

### Previous Experience:

- Getting a script made and produced for a spoken audio tour takes a long time.
- 8 years of hands on work experience.
- Finding tour guides can be difficult sometimes.

### Expectations:

- This will be a new design tool to help improve clarity.
- Once set up, it is minimal maintenance work.
- I need no technical knowledge to use this tech, only knowledge about the art pieces.



## James Kirk

Relevant Quote: I am captivated by the techniques and stories behind historic artworks and how they shaped the world of art.

### Demographics

Gender:	Male
Age:	42
Location:	Glasgow, Scotland
Relationship Status:	Married
Title:	Art History Teacher
Education:	Master's degree in Art History

### Goals

- Gain a detailed understanding of the techniques and stories behind iconic artworks.
- Learn more about the cultural and historical contexts influencing famous art movements.
- Enrich his lessons by deepening his knowledge of art history and artistic techniques.

### Background Description

James is a 42-year-old Art History teacher living in Glasgow, Scotland. He has always been fascinated by the evolution of art styles and techniques across different eras and cultures. James frequently spends his weekends and holidays visiting art museums, galleries, and historic sites to study masterpieces firsthand. His primary interest lies in Renaissance and Impressionist art, focusing on the lives of the artists and their creative processes. James incorporates these experiences into his lessons, aiming to make art history more engaging for his students. However, he often finds museum tours too broad and lacking in-depth exploration of specific artworks or movements.

### Motivations

- Understand the creative process behind significant works of art.
- Explore how historical events influenced artistic expression and movements.
- Make his lessons more interactive and insightful with unique anecdotes and facts.

### Frustrations

- High ticket prices for premium museum exhibitions or tours.
- Limited information on the artistic techniques or the artists' lives in exhibits.
- Group tours often focus on popular works, neglecting lesser-known but impactful pieces.

### Previous Experience:

- Has visited renowned art museums like the Louvre, the Uffizi Gallery, and the Tate Modern.
- Participates in art workshops and lectures to hone his understanding of techniques.
- Frequently reads art history books and watches documentaries on famous painters and sculptors.

### Expectations:

- Affordable / free solution for accessing personalized information
- Easy to use technology to scan and retrieve specific details of artifacts
- A platform offering a deep dive into artistic styles, techniques, and historical contexts.

## Appendix 2: Scenarios

### LLM powered tour guide

Luciano is a tech enthusiast who enjoys understanding new technologies in museums. Today he wants to visit a new exposition in his city at Milan's National Museum of Science, which a friend of his told him about. He became keenly interested when he discovered they were using a new LLM-powered guide. He wants to interact with it and gain insight into how it operates, what data sources it uses, and its actual application in the museum.

Once there, Mark downloads the museum's app. He scans an exhibit using the camera in the app. He is prompted into a chat where the guide provides an overview of the certain exhibit. From here Luciano tries to test the AI, by sending specific questions about the exhibit to measure the precision of the answers. Luciano opts to get more information by pressing the "How it works" menu. At this point, he can ask questions about the process behind the AI guide, for example: "What is the data used to train the AI?" or "How does the app recognize the exhibits?". The guide elaborates on an answer in which he explains the recognition system, the museum data sets and the use of vision models.

Luciano is satisfied with the answers and continues to test the AI by asking what other exhibits he should see, based on the fact that he liked this one. The AI suggests relevant exhibits and Luciano is happy with the interaction. Luciano goes on to finish the tour.

### Scenario 2B for A person provide 2 painting and LLM model compares it

It was a chilly winter morning when Nick Jones walked into the Rijksmuseum. As an art student at the Gerrit Rietveld Academie in Amsterdam, he had always been fascinated by Dutch Painters like Rembrandt and Vermeer. Today, he was once again aiming to see if he could unearth lessons from these 17th-century Dutch paintings.

As he strolled through the art galleries, Nick saw two paintings that caught his attention: Johannes Vermeer's "The Milkmaid" (1660) and Pieter de Hooch's "The Courtyard of a House in Delft" (1658). Both works showcased the elegance of Dutch domestic life during the Golden Age. Nick was interested in their similarities but also sensed that each painting told a different story. Then Nick saw the museum had this new program to learn more about pieces by analyzing a comparison. Curious, he scanned the QR code, went to the site and selected both aforementioned pieces to be compared. After a few seconds, the results were ready: two side-by-side images with captions highlighting their differences. According to the comparison, both paintings depicted scenes of everyday life in 17th-century Holland. However, while "The Milkmaid" focused on the simple actions of everyday life, "Courtyard of a Nobleman's House" meanwhile appears to be more focused on portraying how to act.

Reading further, Nick scrolled through the analysis, absorbing insights about composition, lighting, and symbolism. As Nick continued to explore the exhibit, he found himself using the app multiple times to compare different paintings, choosing which artworks to compare and discovering new facts about each piece. This personalized approach made the museum visit feel more meaningful and engaging.

## Scenario 2B for AR tour guide:

Luciano Castanni, a 31-year-old electronic engineer, wants to visit the exhibition about the ancient tools and technologies in Milan. As someone passionate about both technology and history, he's intrigued by how museums integrate modern tech into their displays. Firstly he makes a reservation to ensure that the pair of glasses is available at sight. Then he takes a pair of AR glasses from the kiosk as part of his visit. Luciano has a particular interest in seeing how cutting-edge technology and interactive elements are applied in the exhibition.

As he approaches the stand with the ancient tools, the AR glasses activate and offer detailed descriptions of how these tools evolved over time. Luciano can observe high-resolution 3D models of the artifacts. Additionally, the models are animated in a way that shows how each tool was applied in its historical context. The system also overlays extra content, such as videos on the manufacturing techniques and the historical significance of the tools. After spending some time at a particular artifact that he is interested in, and he has gathered a lot of information about it, he gets a suggestion to move to another artifact, as the museum is getting full at that time.

Luciano's experience can be customized further by selecting a virtual tour guide section that explains the connections between ancient tools and modern technology, which helps to understand how those tools are related to the devices and equipment he works with daily. While exploring, he can pause the guide and dive deeper into specific facts, and get detailed background information without feeling rushed, which is an advantage for him as during the traditional tours the guide moves too quickly for his liking.

## Scenario 2B for Filling Form for Personalized Route:

James Kirk, a high school teacher, visits the museum to increase his knowledge of Renaissance and Impressionist art history. He specifically wants to learn about the techniques used by the artists and the cultural influences behind their masterpieces but finds traditional museum tours, plaques, and guides too generic and time-consuming.

At the entrance of the museum, he encounters an AI-based solution that offers personalized routes tailored to the interests of visitors. He fills out a form at the entrance providing details about his focus on art history, preferences for content, and time constraints. The system processes this and outputs a customized route that prioritizes exhibits featuring renowned paintings, sculptures, and artistic techniques relevant to him.

James initially had to download an app on his phone and then create an account there. He then fills out the entrance form on the digital display just before the entrance. He inputs his account details, his interest (art history including techniques and cultural influences), time constraints (around 2 hours), and his preference for detailed and niche content. The AI processes this and shows him a customized route on his smartphone app, starting with an exhibit featuring

masterpieces from the Renaissance, skipping general displays on decorative arts or less relevant exhibits.

At the end of his visit, James visited the exhibits that were tailored to his interests. He leaves with detailed information regarding artistic techniques and cultural contexts, which interest him the most and which he also uses to enhance his teaching and personal knowledge. This experience saves him time and provides him with detailed personalized information, making his museum visit more enjoyable.

## Scenario 2B for QR codes with personalized information next to artworks

One Friday evening, Christina Smith wanted to unwind after a tiring shift at work. She read in an article yesterday that a new exhibition opened at the local art museum that she didn't know much about, but was eager to experience. Usually, she does some research beforehand so she can understand the pieces better, but this time she didn't have the time.

When she got there, Christina was surprised to see that the museum was also introducing a new QR code technology to help people know more about the artworks in a personalized way. She was asked to make an account on the museum website and fill in a form where she answered questions such as "On a scale of 1 to 5, how much do you know about art?" (she picked a 4) and "Pick at least one of these topics that interest you: ..." (she chose history, technique and biographical data). She then went ahead to the exhibit where she noticed each piece had a corresponding QR code next to it. Christina pulled out her phone, opened the website and clicked on a little camera button, which allowed her to scan the code.

She was pleasantly surprised to see a bunch of information about the painting that she found really interesting! The text was about the era the painting was made and the events of that time that resulted in the painting being made. Also, there were quite a few details about how experts believe the painting was made, such as the direction of strokes, color application and so on. She even found details about the painter's life and his career path. She couldn't believe it, all this information in one spot!

Even though the exhibition was quite small, it took her about one and a half hours to get through it all, yet she couldn't have been more excited by the end of it. She took notes on interesting details she would like to research later and was given quite some in-depth information, considering she mentioned in the form she was pretty knowledgeable about art.

On her way out, she mentioned to the exhibit curator how thankful she was that a lot of her questions could be answered so conveniently, without needing to ask different people about them.

## Appendix 3: Interviews

### Interviewing Tech Geek:

The tech geek likes to go to museums to look at art in real life, but also to learn more information and have fun facts to tell people. In order to get more information he likes to read the cards next to artworks, or just ask around and Google it, however he often does not go out of his way to do so.

When asked about how he likes to get his information, he said he likes audio guides. He would never download an app and would prefer not to make an account to use facilities. The only technology he's used in a museum is the audio guides, which he sometimes likes depending on their quality and user-friendliness. He is not aware that other types of technologies are used in museums, but he did go to a VR museum using a headset. He also used some AR and he did not like it at all, because of the video quality and controls.

He likes the possibility of getting additional information about art, but if it's convenient, because you can always Google information but that is not fun. If he does look stuff up online he likes to use Wikipedia. When going to a museum, he is annoyed by how crowded it gets. Robert said he would be very interested in the possibility of customizing your own route, such that you can avoid the stuff you are not interested in.

For supplying the museum with personal preferences, he does not really feel like it, but if he had to he would like an online form. He likes the idea of highly interactive technology in museums if it also grants an added layer of complexity, otherwise it's just in the way and distracts from the pieces. Also he is afraid that technology not complex enough would not supply enough new content for it to matter.

He would like to get his specific questions answered if the information is correct and it is convenient. He would like a more personalized experience in art museums as long as it adds to the overall experience, it supplies easy in-depth information and it makes it easier and more fun to gain knowledge.

### Interviewing someone who does not like large crowds 1:

#### **1. Do you like art museums and exhibitions?**

Yes, I enjoy art museums and exhibitions.

#### **2. What is your goal for visiting the museum (e.g., learn, only look at art pieces, get some background information, etc.)?**

My main goals are to have an enjoyable experience observing artifacts and to learn interesting facts.

#### **3. When you visit a museum, and you want to learn more about an exhibit, what do you do?**

I typically read the plaques near the exhibit or, occasionally, ask museum staff, although they often lack the specific details I seek.

**4. When getting additional information in a museum, what form of communication do you prefer (audio, text, video, etc.)?**

I prefer reading information on plaques. While I appreciate videos, I dislike audio tours because wearing headphones isolates me from the museum's ambiance.

**5. Are you willing to download the museum's app to get additional services?**

No, I find downloading an app for each museum visit tedious and unnecessary.

**6. Would you be willing to make an account to access museum facilities?**

No, I am unwilling to provide my email due to concerns about promotional spam. A random ID for sign-in would be preferable.

**7. Have you ever utilized technology in a museum? If so, which one? Did you like it?**

Yes, I have used audio tours and video displays, such as short films. I appreciate videos but dislike audio tours for their isolating nature.

**8. How would you evaluate current technological features in museums?**

While many museums integrate technology effectively, they should avoid overdoing it to the point where it overshadows the artifacts.

**9. Have you ever utilized AR? If so, what is your opinion on it?**

Yes, I have used AR in a museum exhibit and found it enjoyable. However, I was frustrated by the need to download an app.

**10. How easy is it to get the desired information (in-depth one) about an art piece? Which tools do you utilize?**

It can be challenging to get in-depth information. I rely on plaques and occasionally ask staff, but they often cannot provide the level of detail I want.

**11. (ONLY FOR PARENTS) What challenges do you face in keeping kids entertained in a museum?**

(Not applicable.)

**12. (ONLY FOR PARENTS) Would an interactive environment designed for kids help you? If so, how?**

(Not applicable.)

**13. What is the biggest disadvantage for you in visiting museums?**

The biggest disadvantages are the lack of chronological order in exhibit routes and large crowds, which can make it difficult to view exhibits and plaques.

**14. Do you prefer group guided tours? Why?**

No, I prefer exploring the museum on my own so I can go at my own pace.

**15. Have you experienced any personalized features in a museum?**

Not extensively, but I think personalized content could enhance my visit by providing more in-depth information.

**16. Can you think of a time that a particular format (AR/audio tour) enhanced or detracted from your visit and why?**

AR enhanced my visit, but the requirement to download an app detracted from the experience. Audio tours detract because they isolate me from the ambiance.

**17. If you could customize your own route, what factors would be most important to you (e.g., time, interests, difficulty)?**

Chronology and attention span would be the most important factors.

**18. If a museum were to ask you about your interests before a visit, how would you like to provide this information (e.g., app, questionnaire)?**

I would prefer a simple questionnaire or form that does not require downloading an app or creating an account.

**19. Do you prefer museum technologies to be highly interactive or simple and straightforward? Why?**

I prefer simple and straightforward technologies, such as QR codes for additional information, because overly interactive features can detract from the authentic museum experience.

**20. What concerns do you have about overly interactive or overly simple personalization tools?**

Overly interactive tools might overshadow the artifacts, while overly simple tools might fail to provide enough useful content.

**21. To what extent do you think technology should be used in museums so that it does not detract or distract you from the actual museum exhibits?**

Technology should be used sparingly and thoughtfully, complementing the artifacts rather than overwhelming them.

**22. What do you think of gaining specific information from museum pieces based on what you ask?**

I think it would be beneficial, especially for gaining in-depth information not available on plaques.

**23. How would you feel about using a personalized route generated specifically for you?**

While I usually prefer to explore the entire museum, a personalized route focused on chronological order could be helpful in some cases.

**24. Do you think you would benefit from personalized content in a museum?**

Yes, especially when I am seeking in-depth information that is not available on the plaques.

**25. Do you prefer to get in-depth information from the museum exhibitions?**

Yes, I enjoy learning detailed and interesting facts about the exhibits.

Interviewing someone who does not like large crowds 2:

**Do you like art museums and exhibitions?**

I do like the art museums and exhibitions, however I find it difficult to get into the meaning of what some of the things that can be seen there portray. I have been to a couple and sometimes it can be highly abstract or a message that can be highly unclear, yet I see people praising it, however other than that it can be pretty nice.

**What is your goal for visiting the museum (e.g learn, only look at art pieces, get some background information, etc.)?**

It depends, mostly just, if its art, mostly entertainment, if it is a museum continuing historical artifacts, or anything like that, it is to learn something new.

**When getting additional information in a museum, what form of communication do you prefer (audio, text, video, etc.)?**

Well, from my experience, the best thing to do would be to read what is written near the tablet of what I am looking at, as all the museums contain them.

**Are you willing to download the museum's app to get additional services?**

Definitely text, sometimes I find it hard to understand other people

**Would you be willing to make an account to access museum facilities?**

Absolutely not, usually whatever an museum provides with an app is not worth the 10 seconds it takes to download the app, especially registration or something like that

**Have you ever utilized technology in a museum? If so, which one? Did you like it?**

Absolutely not, I do not wish to add any more accounts to the pile

**How would you evaluate current technological features in museums?**

First the interactive maps of the museum, they are very useful. Second one is the interactive tablets or books near art or historical pieces.

**How would you evaluate current technological features in museums?**

Varies drastically, for example the ones in my home country have no technology. In well developed countries have technology and are pretty nice

**Have you ever utilized AR? If so, what is your opinion on it?**

I have never used AR or VR

**How easy is it to get the desired information (in-depth one) about an art piece? Which tools do you utilize?**

If there is an art piece I want to learn more about there are 3 things: First off the tablet, however that information is small or might miss something. Second is the website of the museum or art piece. The last option is to google or Wikipedia

**What is the biggest disadvantage for you in visiting museums?**

I would say the biggest hurdle in visiting museums are other people. When you go to such a place, you expect some civility, and being slightly more adequate than on the streets. Practice proves otherwise. Like families with small children that touch the pieces, people who are noisy, distracting, jerks, distracting, etc.

**Do you prefer group guided tours? Why?**

Guided tours I am not a big fan of, I have my own pace. Tour guides vary drastically in how enjoyable they are. I prefer not to have any guides

**Have you experienced any personalized features in a museum?**

No, I don't think I ever did

**Can you think of a time that a particular format (AR/audio tour) enhanced or detracted from your visit and why?**

Actually exactly one, In Canada, an audio tour on Canadian history. Really enhancing the history as the narrator narrated the events that transpired, it felt like a really cohesive story that really happened. Really nice.

**If you could customize your own route, what factors would be most important to you (e.g., time, interests, difficulty)?**

I don't think I would ever think about such things, I mostly wander around aimlessly and observe and learn. I would never build a route in advance

**If a museum were to ask you about your interests before a visit, how would you like to provide this information (e.g., app, questionnaire)?**

I believe questionnaire would be preferable

**What concerns do you have about overly interactive or overly simple personalization tools?**

Heavily depends on the museum and the theme. Sometimes intractability is not needed and better absorbed if it was simplified.

**To what extent do you think technology should be used in museums so that it does not detract or distract you from the actual museum exhibits?**

Once again depends on the museum, if it would be an art museum that consists mostly of modern art, I believe having a bit more tech in there would be part of the experience, while such a thing in a history museum would break immersion

**What do you think of gaining specific information from museum pieces based on what you ask?**

That would be a nice feature, however its implementation would ask me to be familiar with the piece presented. Thus I believe it should be some kind of questionnaire when you visit these.

**How would you feel about using a personalized route generated specifically for you?**

I don't like routes, I don't like plans, and I definitely don't like any kind of personalised route

**Do you prefer to get in-depth information from the museum exhibitions?**

Yes, definitely

Interviewing student who wants to deepen his knowledge:

1. Do you like art museums and exhibitions?  
o YES
2. What is your goal for visiting the museum (e.g learn, only look at art pieces, get some background information, etc.)?  
o Learn and get background information about the exhibits
3. When you visit a museum, and you want to learn more about an exhibit, what do you do?  
o Read all the available material.

4. When getting additional information in a museum, what form of communication do you prefer (audio, text, video, etc.)?
  - Usually text, but video is nice
5. Are you willing to download the museum's app to get additional services?
  - Yes, only if the size is small
6. Would you be willing to make an account to access museum facilities?
  - Yes only if I have quick connect options
7. Have you ever utilized technology in a museum? If so, which one? Did you like it?
  - Headphones,
8. How would you evaluate current technological features in museums?
  - Outdated, nothing new
9. Have you ever utilized AR? If so, what is your opinion on it?
  - Yes, I like them , but it can be a burden
10. How easy is it to get the desired information (in-depth one) about an art piece? Which tools do you utilize?
  - The art has a text plate describing, crowds can be a problem
11. (ONLY FOR PARENTS) What challenges do you face in keeping kids entertained in a museum?
12. (ONLY FOR PARENTS) Would an interactive environment designed for kids help you? If so, how?
13. What is the biggest disadvantage for you in visiting museums?
  - A crowded place, no material in international languages,
14. Do you prefer group guided tours? Why?
  - Usually, by myself
15. Have you experienced any personalized features in a museum?
  - No
16. Can you think of a time that a particular format (AR/audio tour) enhanced or detracted from your visit and why?
  - Audio can be nice, but sometimes annoying
17. If you could customize your own route, what factors would be most important to you (e.g., time, interests, difficulty)?
  - I'd like to get the shortest path based on my interest
18. If a museum were to ask you about your interests before a visit, how would you like to provide this information (e.g., app, questionnaire)?
  - I'd find it very easy to have a talk with an LLM model or a person.
19. Do you prefer museum technologies to be highly interactive or simple and straightforward? Why?
  - It depends on what you're visiting. When it comes to art museum, interaction is very nice. I think I'd get more information and engaged. But it shouldn't overwhelm the art piece by itself
20. What concerns do you have about overly interactive or overly simple personalization tools?
  - The overly interactive can steal the attention from the art. The overly simple is less engaging and harder to get all the information that you want.

21. To what extent do you think technology should be used in museums so that it does not detract or distract you from the actual museum exhibits?
  - o Technology is a good thing to implement in the museum, but the museum shouldn't base 100% on that.
22. What do you think of gaining specific information from museum pieces based on what you ask?
  - o The idea of an LLM model sounds good when it comes to gaining specific info
23. How would you feel about using a personalized route generated specifically for you?
- o I think it's very cool, but this can result still in overcrowding if you have common tastes.
24. Do you think you would benefit from personalized content in a museum?
  - o Yes, for sure, a lot of people my age and younger would, because these generations are more accustomed to technologies.
25. Do you prefer to get in-depth information from the museum exhibitions?
  - o Yes, but only if I can choose when I want more information or not.

### Interviewing parent with kids:

When we asked a parent with kids whether she likes to go to art museums, she said that she does, but she does not get much time to do so. She took an art class in college and the passion stuck since then. Her goals when visiting museums is looking at art and learning more about the paintings and the painters. She also sometimes does research online before going to a museum and learns about some of the exhibits.

When it comes to the ways she likes to get extra information in museums, Linda likes audio tours, but that also depends on how user-friendly the tour is, whether you can easily skip between recordings and keep track of where you are in the museum. She wouldn't want to download an app nor make an account using her email, due to future potential spam. She has only utilized QR codes as a museum technology before, other than the audio guides. She has no experience with AR or VR. She finds it quite easy to find information herself on more popular artworks, but the lesser known it is, the harder it gets.

When it comes to her kids, she finds it hard to keep them entertained in a museum. They are not that interested in art, they get impatient and want to go home. They like more visual stimuli, more colors and shapes, so an interactive environment for them would probably help. Some disadvantages she finds at museums are other people in bigger groups, it's harder to get around them and also some artworks that do not feel like they belong, or are there just to fill the space.

Linda likes guided tours, because you are talked to by an expert, but she does not like that she feels rushed and can't move at her own pace. She hasn't experienced a lot of personalization, only the audio tours she has already mentioned. If she could customize her own route, the criteria for it would be things like chronology or maybe separated by artists, but she would be fine with any criteria as long as it makes sense. If she had to give information such as preferences to the museum, she would like to do that through an online form.

She would prefer a low tech solution over a high tech solution, because she likes to be immersed in the experience and be as present as possible and if she has to figure out how to use a piece of technology it would not be great. She would however be open to high tech

solutions if they are really interesting and extraordinary and offer something much more to the experience. She likes the idea of being able to ask questions about art pieces at any time and receive a swift, in depth answer.

### People who are specifically interested in a certain topic

What is your goal for visiting the museum (e.g learn, only look at art pieces, get some background information, etc.)?

Usually combine extra information and looking at art pieces.

When you visit a museum, and you want to learn more about an exhibit, what do you do?

Look at information provided, look for additional information online, even get a guide if I'm really interested.

When getting additional information in a museum, what form of communication do you prefer (audio, text, video, etc.)?

In priority order: audio, text, video.

I feel the video may be distracting from being present and looking at the actual exhibits of the museum. There can be segments - like special rooms in museums (these do exist already) narrating a story. But they are an addition to the exhibits, not a replacement. In this form video is okay, otherwise it would be distracting.

Are you willing to download the museum's app to get additional services?

Sure. Depends of WiFi availability.

Would you be willing to make an account to access museum facilities?

Depends on the personal data required. But I would rather not add any more steps, as planning visits is already time consuming.

Have you ever utilized technology in a museum? If so, which one? Did you like it?

I have been to rooms that show a video, narrating a specific story. Also, I have made use of audio - narrating information about exhibits and have encountered interactive parts at museums (e.g. For environmental impact etc.). All were fine.

How would you evaluate current technological features in museums?

Good.

Have you ever utilized AR? If so, what is your opinion on it?

No.

How easy is it to get the desired information (in-depth one) about an art piece? Which tools do you utilize?

In depth information usually is acquired before visiting a museum or after. I think that such knowledge can only be acquired by devoting hours on a certain piece of art - by conducting research.

(ONLY FOR PARENTS) What challenges do you face in keeping kids entertained in a museum?

(ONLY FOR PARENTS) Would an interactive environment designed for kids help you? If so, how?

What is the biggest disadvantage for you in visiting museums?

Sometimes expensive tickets plus the lack of spots to rest, especially if it's a very big museum.

Do you prefer group guided tours? Why?

I have done it only once, it was a nice experience and it did help since the museum had limited information about the exhibits.

Have you experienced any personalized features in a museum?

No.

Can you think of a time that a particular format (AR/audio tour) enhanced or detracted from your visit and why?

Audio tour was nice, since the tour was being provided in a language I didn't know. However, it does take away from the experience of sharing it with others you may be visiting with, making it a more solo/isolating experience.

If you could customize your own route, what factors would be most important to you (e.g., time, interests, difficulty)?

Time, interests, efficiency.

If a museum were to ask you about your interests before a visit, how would you like to provide this information (e.g., app, questionnaire)?

Questionnaire would be fine.

Do you prefer museum technologies to be highly interactive or simple and straightforward?

Why?

Simple and interactive - as in with other humans too. Simple so it's not too hard or time consuming to learn how to use, and interactive because it would be more interesting and fun.

What concerns do you have about overly interactive or overly simple personalization tools?

Overly interactive can be too distracting - overly simple can be boring. Also there should be a clear reason as to why such things are necessary and if they enhance knowledge, the experience etc. Otherwise this may be redundant.

To what extent do you think technology should be used in museums so that it does not detract or distract you from the actual museum exhibits?

It should be there to enhance or make the experience easier. To foster more information.

What do you think of gaining specific information from museum pieces based on what you ask?

That would be potentially interesting but I would like to also know the sources being used for providing such information.

How would you feel about using a personalized route generated specifically for you?  
Would need more information on how this may look like, but I would try it.

Do you think you would benefit from personalized content in a museum?  
Potentially yes.

Do you prefer to get in-depth information from the museum exhibitions?  
See answer above about what constitutes in depth knowledge. But also, this depends how invested I am for the exhibits

## Appendix 4: Complete user study results (lo-fi)

### Person 1 User Study:

The user started by going straight for the camera scanner icon, not noticing the description of the different modes. They said that because of the way it's laid out, their eyes jumped straight over it, thinking it was filler text. After they see it, they choose the "Regular" mode and go to scan a painting. They then choose one of the predefined questions. They were hoping to see a back button in order to go back to the database, but there wasn't one. They then pressed the home button to try out the database feature as well. They looked at it and noted that there are no filtering features so they just pressed one of the 3 paintings and from there, the chat process is the same as with using the camera. This is where the prototype demo ended, since there were no more features to highlight.

For the questions phase, the user really liked the suggested questions idea and said they find them appropriate. They like that there are two options for selecting a painting: scanning and database. Also they like the modes, but they think they might be wrongly named and poorly described, so people do not exactly know what to choose. The user then said that the personalized feature of the bot referencing past paintings in current queries is nice, since it gives context to why those paintings are related. They also said that if a museum had this web app implemented, they would give it a try. When we asked about what technology they would prefer for the painting scanner, to which they responded they would rather have QR codes than scanning the picture itself, since QR codes are more intuitive and easier to scan (because of stuff like lighting, shaky hands). They also mentioned how keeping a chat log somewhere is nice, so that the user can then revisit what had been said.

When asked to rate the three main tasks: choosing a mode, scanning/ database picking and asking a question; they rated them as such: 3/5 for choosing the mode, since it was not really clear what each mode meant; 3/5 for scanning or database picking, since the database did not have any features, but the scanning was nice; 5 for asking the questions, since they liked the predefined questions and thought they are good questions to ask.

### Person 2 User Study:

The user study conducted aimed to gather further feedback for Art2D2. The study was conducted by first letting the user choose a mode, then allowing them to "scan" a painting, followed by getting information on the painting. Overall the interaction was positive, although there was some error when it came to searching the database.

The feedback provided highlights in some key areas. Most notably, adding predefined questions and allowing for easier navigation. Suggesting multiple additional options, such as being able to search for artworks with a search function, in addition to the scanning functionality. Furthermore, feedback was provided on the UI, specifically, adding additional feedback for

actions taken, like it signalling it is currently taking a scan when the button is pressed.

Another important factor for this user, as a parent, is how it could be used by children. Specifically activities for kids that are more interactive or hands-on. Since our implementation is on a phone, a more “tangible” approach might be difficult. However, options like puzzles and quizzes can be looked into.

## Person 3 User Study:

This interview provided valuable insights into the Lo-Fi prototype for interacting with art pieces. The user appreciated the option to choose between different modes, adding versatility to the prototype. However, they found the user interface lacking in appeal and design, suggesting the need for significant improvement.

When asked about the scanning feature, they were enthusiastic about it, particularly the fact that you could converse with a chatbot immediately after scanning. The user expressed a preference for QR codes over scanning a painting, citing the ease of implementation and use. To enhance the scanning experience, they recommended adding helpful tips, such as stabilizing messages or popups indicating the way in which the user should scan and not move too much with the camera or point it correctly. They also suggested a clearer message stating that you have to now scan a QR code that should appear for the user.

Despite these strengths, the user seemed to be confused when interacting with the predefined questions, suggesting the need for a clearer way of presenting them. However, they did like the presence of these questions once their purpose was explained.

They also had a positive view of the chatbot's ability to remember previous visits and create a tailored experience. Additionally, they suggested further enhancements, such as allowing users to view a history of scanned art pieces or offering related works by the same artist.

The user was confused, however, with the database feature, which they initially assumed contained the paintings that he had already scanned but in actuality contains all the paintings in the database. They also proposed the possibility of the system being able to show other artworks by the same artists if that is what the user desires.

As stated before, the user liked the idea of personalized text that they receive where the model keeps track of the previous paintings visited, but they stated that while it could be engaging, it could become overwhelming if overdone. They also liked the idea of a quiz feature, such as testing users on the art pieces they scanned or visited during a museum tour, to boost engagement. They suggested that the quiz be conducted at the end after having finished the visit.

The user rated the selecting mode feature as 5, the scanning feature as 4, and the asking questions feature as 5.

## Person 4 User Study:

For this interview, we walked the user through all the features of the prototype. We initially showed them the various modes that can be chosen from which alters the way the chatbot communicates with the user. Subsequently, we continued with explaining to them the problem and then we initially showed them the scanning mode where a painting could be scanned and then a set of predefined questions appeared along with a chatbot that you can communicate with to get more information. They found this manner of getting information very useful. They also liked the feature of predefined questions as they were interested to know what some commonly asked questions of art pieces were without having to type them out. We then informed the user about the memory feature where the paintings which they visit are remembered and the subsequent responses are tailored according to the visits which were also praised. They however got confused with the database feature as they didn't initially understand its purpose. When explained to them, it was stated that they wouldn't use it themselves as they would prefer to just go to paintings rather than looking at a database with pictures and then deciding the route. Overall, aside from the database option, they had a positive view of the rest of the features.

A big takeaway from this interview (as it was the first) is to have a more hand off approach. And instead of explaining the features, and taking the role of guide, we are meant to take the role of observer. Only clarifying details if they are related to missing functionality of the prototype. Having applied this method, future interviews yielded more useful information.

## Person 5 User Study:

The participant successfully completed all of the tasks. They started with choosing the mode from the provided options in the dropdown, i.e. completing the first assignment, which took approximately 15 seconds. After that they proceeded to scan a painting, which took around 3 seconds. At this stage the participant already pointed out some issues. The main one is that there was no option to go back to the previous step. Next action that was completed - one of the provided questions about the painting was chosen, and more information appeared on the screen, which took approximately 10 seconds. Next step that was taken was searching the database, which took around 3 seconds. The interviewee did not go further to scan another painting.

After completing the part with the tryout of the prototype, the interviewer moved to the questions phase. The user expressed that he did not like the design. Additionally, suggested that the selecting mode would be better in the center of the webpage, and not in the right corner, and that the scanning would be better with QR-codes, and not the paintings themselves. They liked the fact that you can change the mode inside one session. One remark that was made is to

implement as many languages as possible for users to be able to communicate in preferred language. Besides, some ideas were provided by the participant. Firstly, the idea of making a quiz was introduced, after clarifying, the quiz for all pieces. Secondly, the idea that was proposed to attach users to sessions without making users to perform additional steps is using the code from the ticket. Another idea that was introduced is to get the context of the paintings in the room when you enter one.

For the rating part the user gave 4 out of 5 for choosing the mode, as it is clear and convenient to switch in the middle of the session, but there was also a desire to choose on the homepage in the middle of the page. He gave 5 out of 5 for scanning, as it was pretty easy and clear, and 3.5-4 out of 5 for asking the question.

## Person 6 User Study:

The user likes the scanning mechanism for recognizing the art pieces but feels uncertain about the usefulness of the different levels of detail the guide can provide.

Moreover, they say that they find it hard to distinguish the potential difference between personalized information and normal information. They say that they would definitely give the web app a try if they stumbled upon it in a museum. After exploring the features more, the user appreciates the inclusion of different knowledge levels and thinks that it enhances accessibility, especially for a younger audience like children. They also find the predefined questions interesting but prefer custom questions.

The user navigated with ease, having a bit of a problem at the beginning when selecting the mode. They later suggested a clearer page that would describe the modes and instruct the user on how to select the modes.

When asked to rate the task, the user provided the following marks: 4 for choosing the mode, 5 for scanning and 2 for asking a question.

## Appendix 5: Complete user study results (hi-fi)

Participant 1 Interview:

QR code was scanned with ease

Given the introduction to our website, with the available features

Went to the database, clicked on "Black Square" and was taken to the chat

Asked the chatbot to tell him "everything", and after about 15 seconds the response came back

Then went to try out the scanner

Scanned the QR code for "Composition with Red, Blue and Yellow"

Then was shown the quiz functionality (only on laptop for now)

How do you feel about your experience?

Extremely easy to navigate, buttons are self-explanatory. Not a fan of the watermark on the front page.

What would you add/remove?

I don't think I would remove anything, doesn't really like the country filter, doesn't think it's useful.

Scanner is fine, one of the links leads to the github page for it, maybe remove it. The interface for the scanner is a bit confusing, remove some of the useless hyperlinks for scanner.

Check whether the camera permission on the phone works on all phones

The chat is fun, the quiz is fun.

Remove the country filter possibly.

Participant 2 Interview:

Was explained the app, was given a QR code to scan.

Scanned the QR code with ease, and shown the different functionalities.

The Scanning feature is a little confusing because of front-end, but was talked through it.

Scanned Black Square, asked a question about it, and in about 7 seconds got an answer back.

Asked another question.

How do you feel about the chat?

Does it use AI? Yes. It's good.

Was then shown the database functionality as an alternative to the scanner.

Thought the DB was very cool.

Then shown the quiz functionality on the laptop.

What did you think about the app?

Really likes the app. He would add codes as a search filter, so like individual painting codes that you can search by. The chat is good, likes the modes functionality, because sometimes you only want some basic information. What ChatGPT misses are clickable buttons for the quiz which are really nice. Since it's AI it can generate different questions every time so it's cool. Scanning function was good, annoying to choose a camera but not really any other option. Make the buttons on front page much bigger.

**Participant 3 Interview:**

Was presented the purpose of our product, and was shown the QR code.

A little trouble with the QR code on our part (the QR code expired) but we got another one working quickly.

Was shown the interface, scanning or database features.

Allowed camera permissions for the scanning.

Explained what the 3 modes did, and told they were probably not getting implemented.

Asked questions about the LLM, the functionality and how it runs, what engine it uses. Seemed pleased with the response.

Was shown the quiz feature, liked the overall quiz and that we kept the same format as the chat, very easy to follow.

FEATURE: click the hyperlink at the top to go back home.

Went through the database, checked out the features.

Asked about how the sorting features were thought out and made, liked the thought behind it.

**What do you like/want to remove?**

Like the idea of the app, how it was implemented. UI is not super user friendly, too much text on the front page. Make the buttons bigger. Art2D2 everywhere, instead of Art Gallery in db. It's okay for a prototype. The hyperlink to the git is annoying. More frontend consistency, after scanning it looks like a different app. Fix the chat UI, make the chatbar fixed to the bottom of the screen. Otherwise it's nice.

**Participant 4 Interview:**

Was introduced to our application and its purpose.

Scanned the QR code with ease.

There are two options, the DB and the Scanner.

Went to the database, clicked on "Composition with Red, Blue and Yellow".

Asked the chat a question, and got an answer within about 5 seconds.

Tried the filters for the database.

Went to try the scanner, apparently it doesn't work with safari, so switched to Chrome.

It allowed camera permission and then it worked.

Is shown the quiz function on the laptop, approved of it.

The different modes were explained.

Everything was nice, easy to use. Annoying with camera permissions on safari. Other than that everything was fine.

**Participant 5 Interview:**

Was introduced to the purpose of our application.

Scanned the QR code easily and reached our website.

Shown the 2 options, DB and Scanner.

Chose the scanner, allowed camera permissions.

Scanned "Composition with Red, Blue and Yellow"

Asked a question about it, and in about 10 seconds got back the answer.

Explained why the mode functionality will likely not be implemented.

Shown the quiz functionality on a laptop.

IDEA: put "generating..." chat box while generating quiz/answers  
It glitched a bit because a bunch of quizzes were taken at the same time so do something to prevent that.

Was shown the database functionality as an alternative to scanning.  
Played around with the filtering functionality.

Anything you liked/would improve on?

I didn't encounter any large issues apart from the quiz bugging, but that was a slight issue on the user side. You can ask any question about the painting which is nice. Navigation is easy, not too complicated. It is intuitive, you know what each click does.

I can't think of anything I would change about it. Nothing obviously wrong with it.

Participant 6 Interview:

Was introduced to the problem our system is trying to fix.

Scanned the QR code, went to the front page.

Chose the scanner, gave camera permissions without an issue.

Scanned a painting and asked a question about it.

Waited for about 7 seconds and got an answer back.

Is shown the quiz functionality, a bit of technical issue at first which will be fixed. Made a comment about saying "try again" instead of answering right away.

Then the db functionality, used the filters a little bit and thought it was nice.

Was explained why the mode functionality does not exist and we will probably not implement it.

Any comments?

Can you ask anything about the artist, or stuff strictly related to the painting? You can technically ask other stuff, but there is no guarantee that there will be a right answer. If it gets too much information it could hallucinate.

What did you think about the UI?

It's a bit sloppy, comments about the chat UI being a bit weird and lack of hyperlink towards the homepage if you click on the title.