

# AR Pop-Up Book: A Venture into Interactive Stories

Cindy Muller

04.04.2024



Master's Thesis in Informatics: Games Engineering

Supervisor(s): David Plecher

# Introduction - Books

- Books have been declared dead many times [1]
- Yet, they are still around due to many reasons [2]
  - Books carry information
  - Reading books can be an enjoyable activity
  - Physical books can be touched, collected and displayed
- Reading is important for educational success and children adopt their attitude towards reading from their parents [3]

# Introduction - Augmented Reality

- More accessible due to rapid spread of smartphones [4]
- Growing field of research [5]
  - Shift in focus to usability and user experience [4]
- Challenging due to fast changes in hard- and software and lack of design guidelines and information [6]

# Goals of this Thesis

- Create a game that could help promote physical books
  - By combining a paper book with an interactive story and AR pop-up elements
- Conduct a user study to assess how the game performs and fits in with existing media

# Related Work

- Research into many different topics
  - Paper Books
  - Augmented Reality
  - Pop-Up Books
  - Puzzles

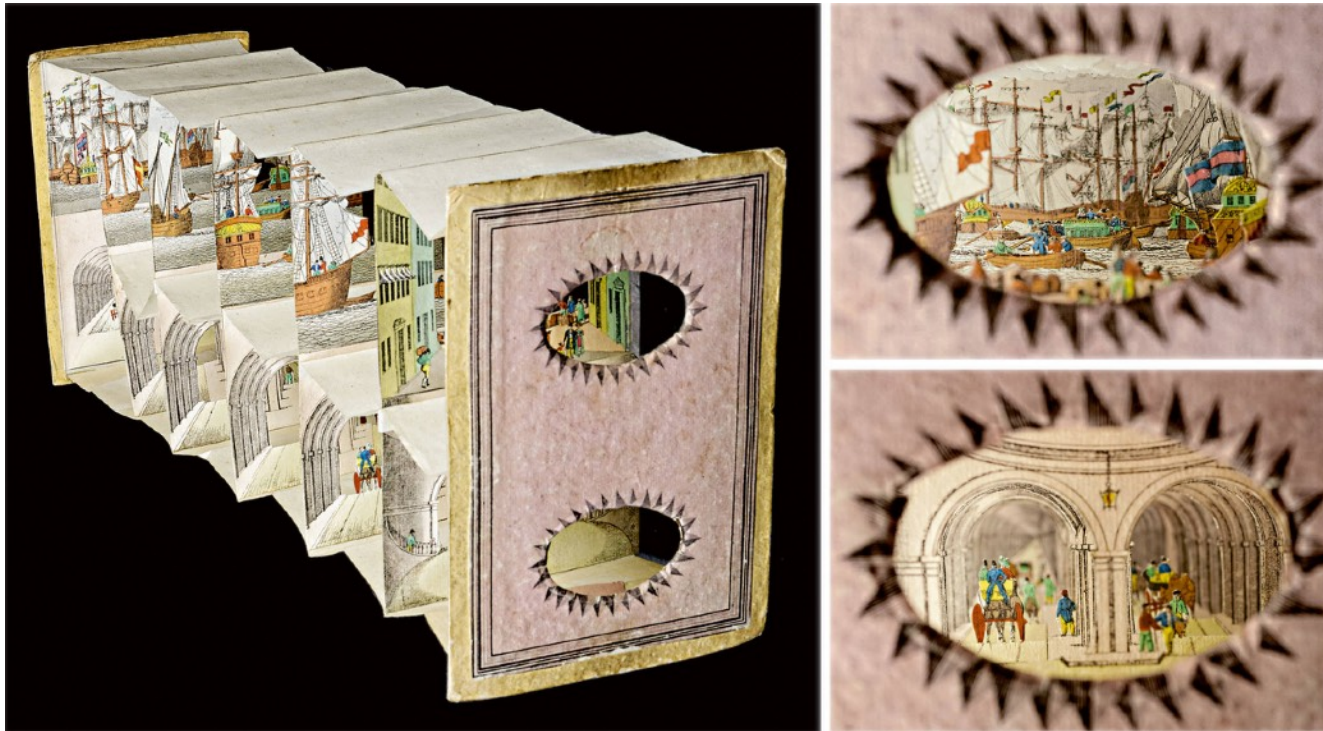
# Related Work - The Magic Book



The Magic Book by Billingham, Kato and Poupyrev (picture from [7])

- Physical Book with printed markers
- Augmentations can be seen through a hand-held display

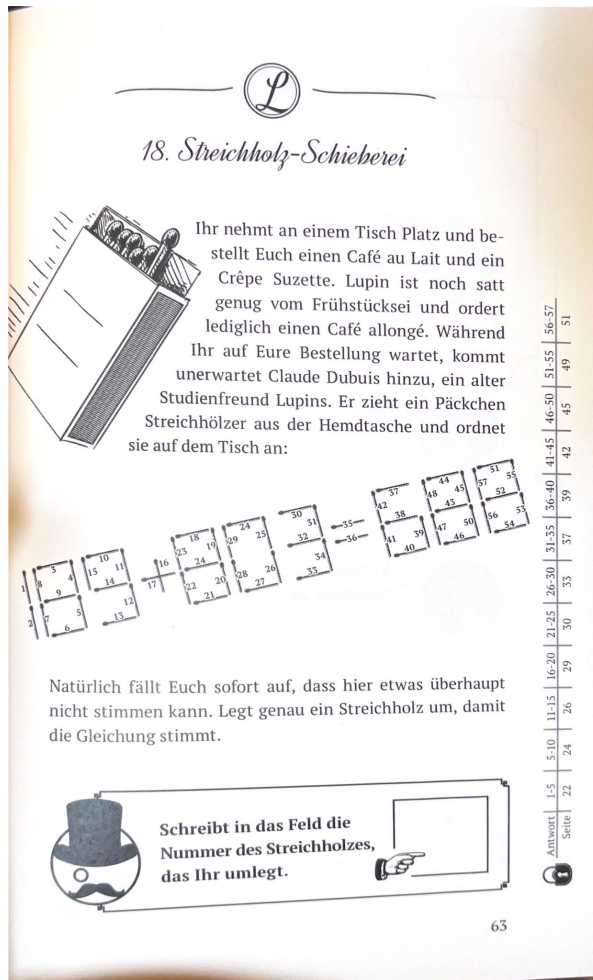
# Related Work - Peepshow Books



Peepshow Book from ca. 1835 (picture from [9])

- Looking into the “peephole” reveals a 3D scene created by strategically placed cut-outs

# Related Work - Puzzle Book



- *Das Rätselbuch des Arsène Lupin* by Daniel Jess
- Reader takes on the role of a master thief in training
- Puzzles need to be solved to complete the final exam in master thievery



# Related Work - Puzzle Advent Calendar



- *Exit Advent Calendar* by Ravensburger
- Players get one puzzle to solve per door

# Game Concept

- Include puzzles to create an interactive story
- Utilise AR to re-imagine existing puzzle concepts
- Story within a story
  - Player finds a mysterious chest that contains puzzles they need to solve
  - Each puzzle unlocks a part of an old Norse tale, *Treasures of the Gods* written by Neil Gaiman [10]
- Assets and textures are largely inspired by Norse myths

# Implementation - Augmented Reality

- Mobile app in combination with the physical book
- Requirements
  - Determine precise location of the book
  - Determine which page is open
  - Stable augmentations
- Combination of markers and plane finding
  - Markers give precise location when in view
  - Unique markers make it possible to identify pages
  - Plane finding allows for stable augmentations

# Implementation - Menu

- Main menu is projected into the scene
- Anchored on top of the marker
  - Indicator if and when marker has been detected
- Offers buttons for users to get help with puzzles, toggle the flashlight, view the unlocked story pages and reset the page

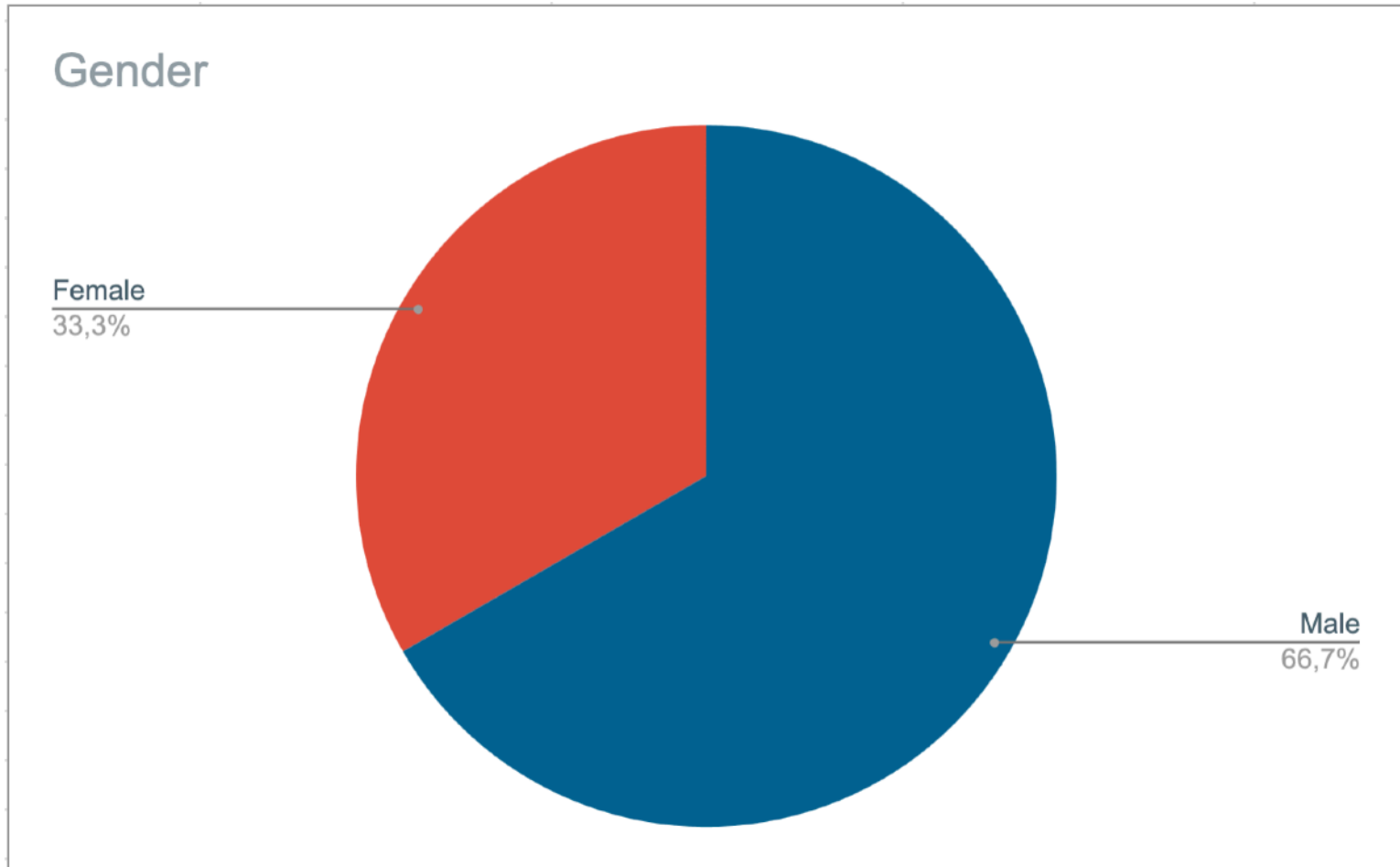
# Implementation - User Interactions

- Full 3D geometric manipulations have 6 DOF
  - Touch Input has 2 DOF
- Multi-Touch gestures are intuitive but can lead to occlusion on small displays [11]
- Two Modes
  - Objects “on the table” can be moved on the plane and rotated around one axis
  - Objects “in the air” can be rotated around three axes

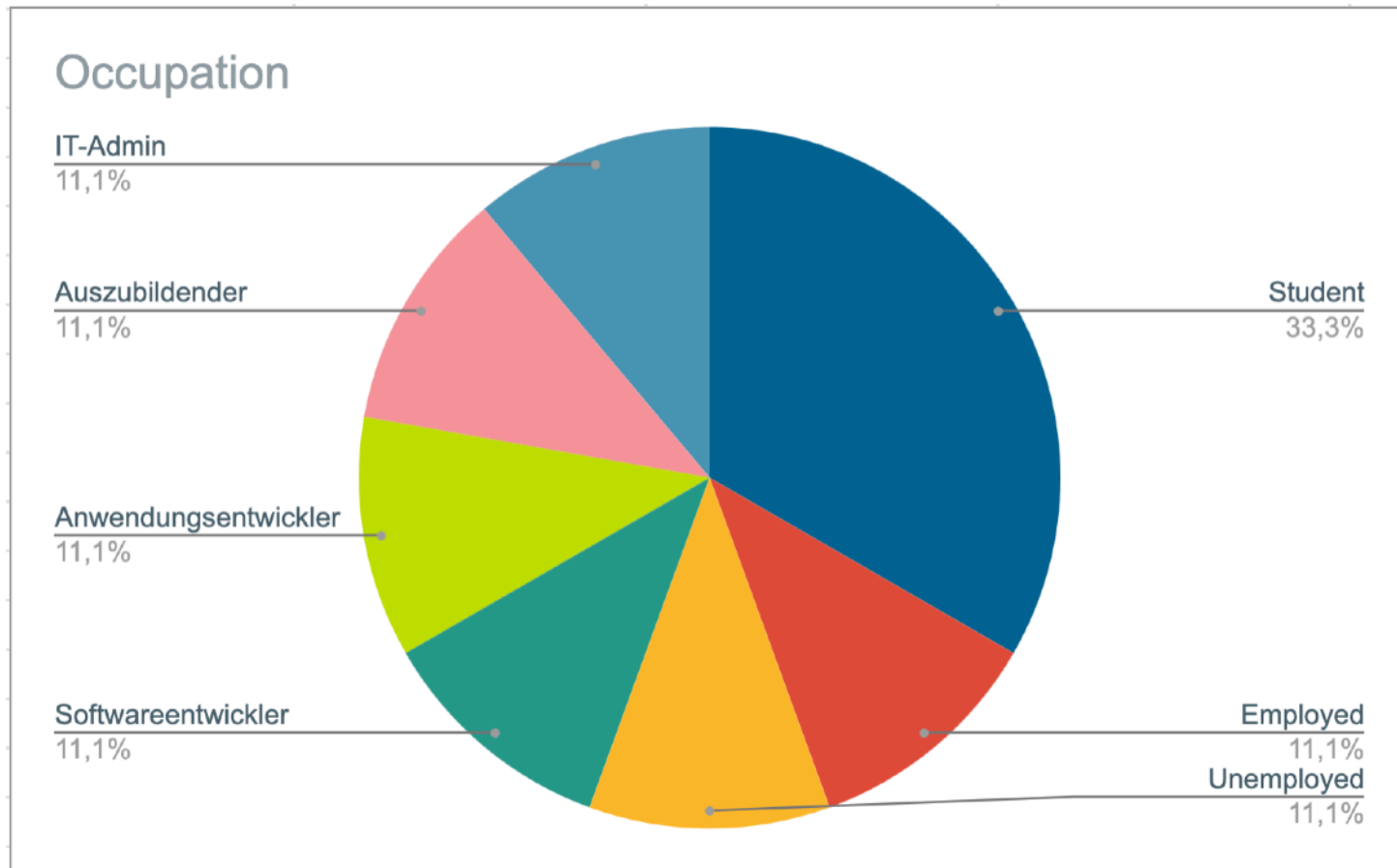
# User Study

- Participants played the game for about an hour and filled out a questionnaire at the end
- Participants were acquaintances or computer science students that showed interest in the project
- 10 participants completed the user study
- Playtime ranged from 37 to 60 minutes (Avg. 53 minutes)

# Questionnaire - Demographic Data

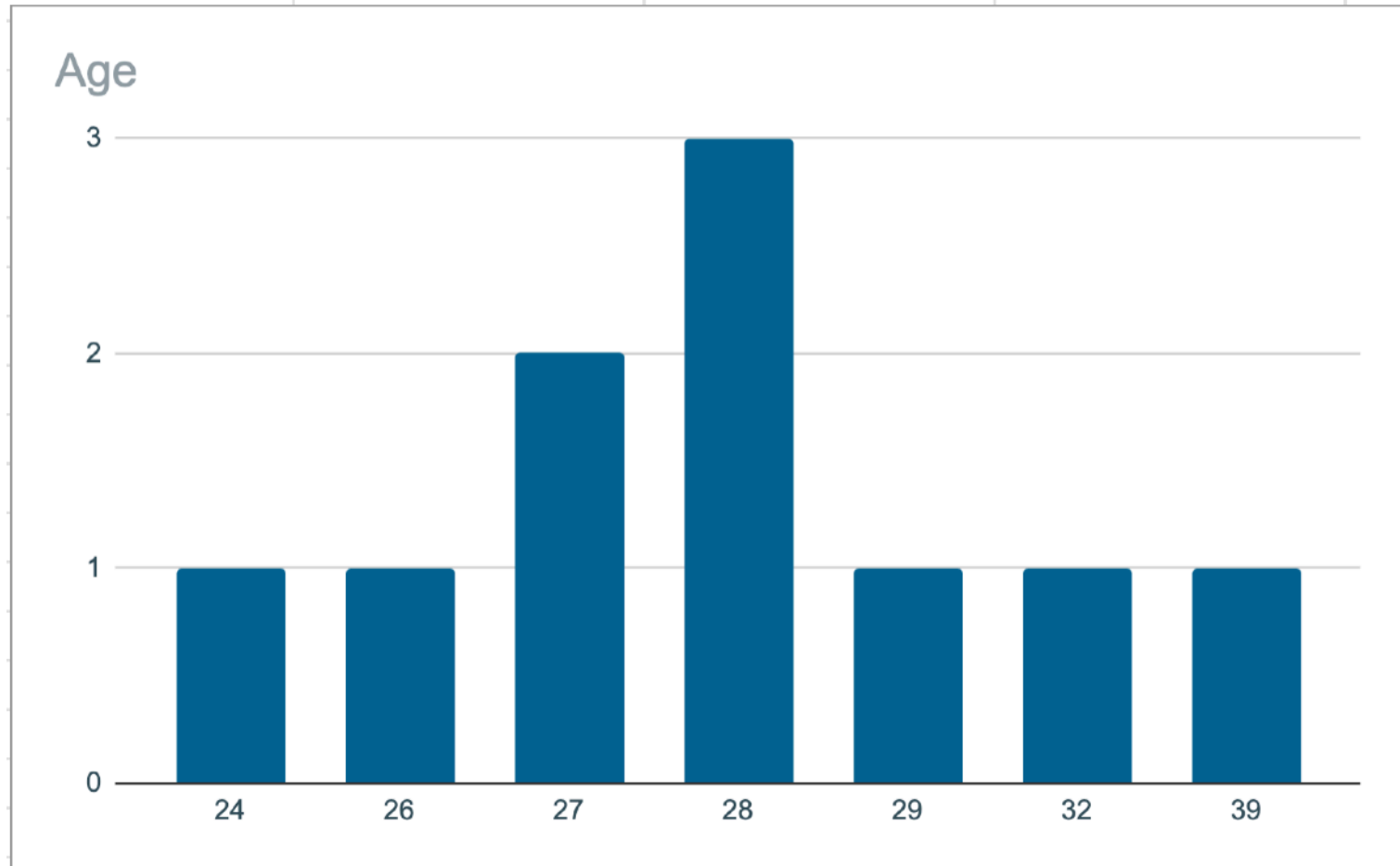


# Questionnaire - Demographic Data

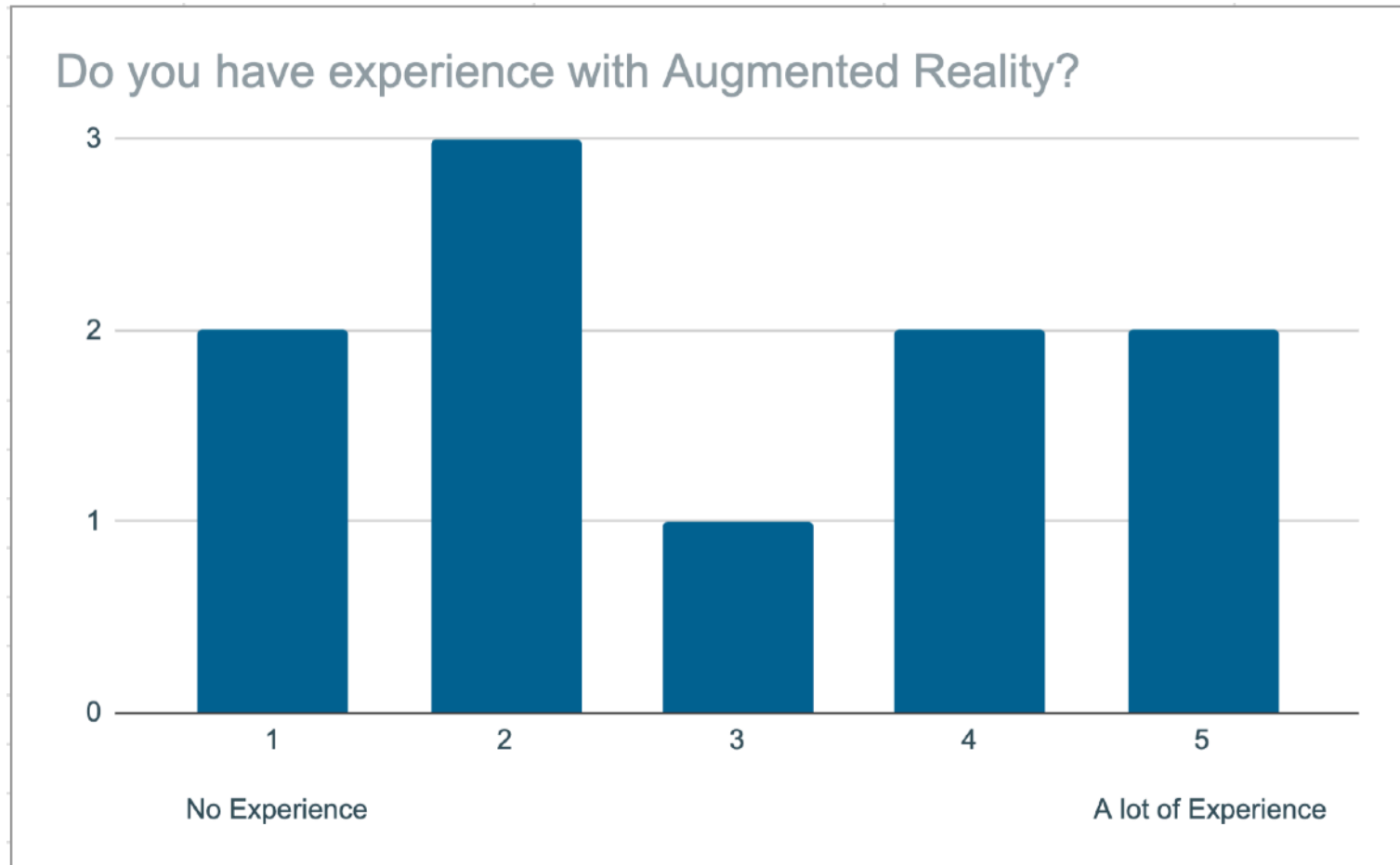




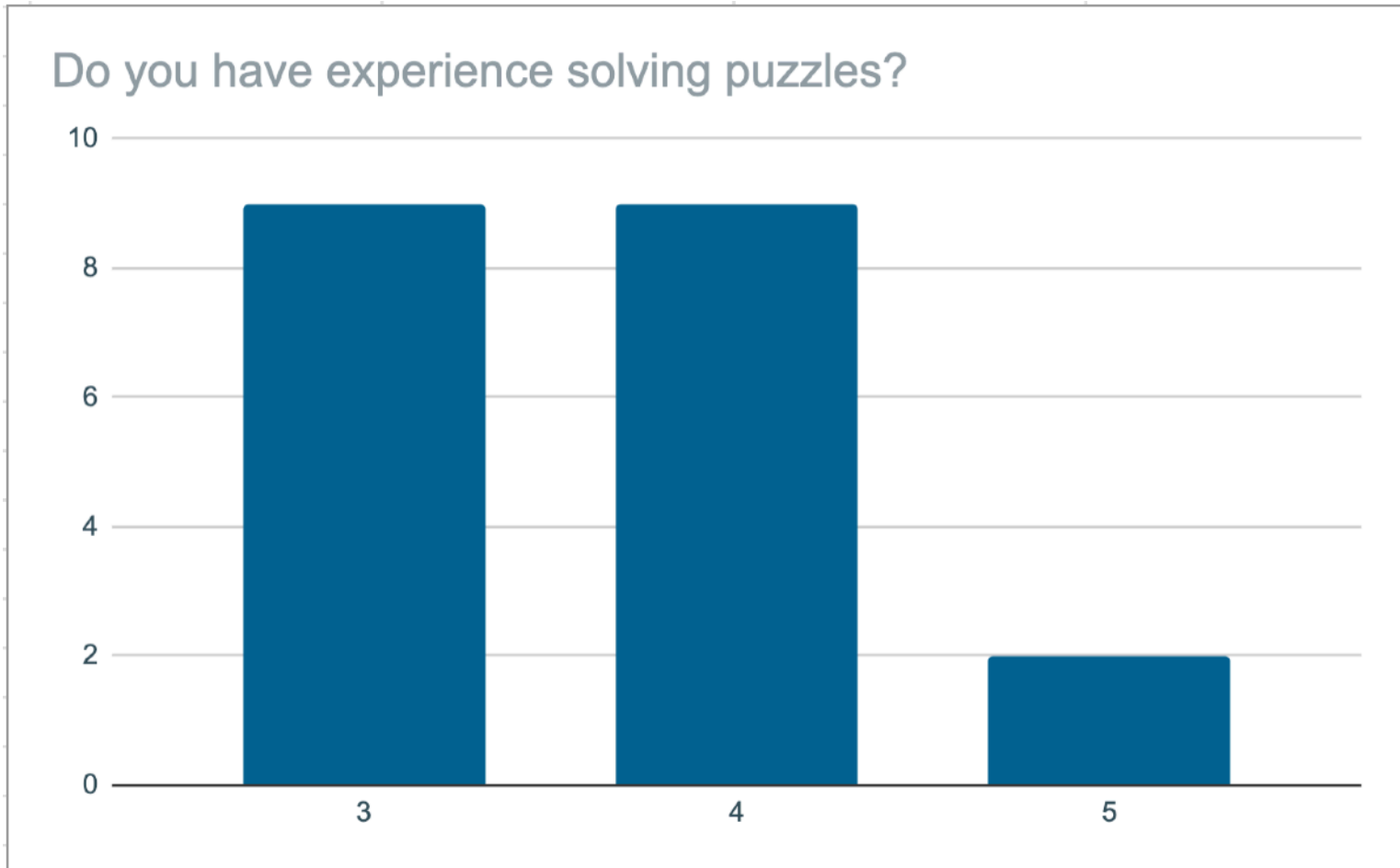
# Questionnaire - Demographic Data



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# Questionnaire - Demographic Data



# Questionnaire - SUS

- System Usability Score [12]
  - Consists of ten items that are ranked on a Likert-scale from 1 (*Strongly Agree*) to 5 (*Strongly Disagree*)
- The game received an average score of 76
  - This corresponds to the grade B [13]

# Questionnaire - Additional Feedback

- Most participants rated the puzzles in the middle between too easy and too difficult
  - All participants solved at least 5 of the 6 puzzles
- Participants felt that this game was more interactive and engaging than mobile puzzle and mystery apps
  - This game could take up some of the time that people currently spend with those mobile apps
- Feedback was generally positive

# Future Work

- Additions to the input system
  - E.g. fixing issues with double taps, different interaction techniques, multi-modal interaction techniques
- Creation of a version of the game that uses HMDs
- Haptic and auditory augmentations
- Creation of custom assets
- Addition of collaborative or competitive aspects
- Further studies on how users would integrate the game into their day-to-day life

# Conclusion

- Research into an interesting mix of topics has lead to the creation of a game that
  - Received a good system usability score
  - Garnered mostly positive feedback from testers
  - Could potentially motivate people to read more and spend time with physical books
  - Offers opportunities for further research

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