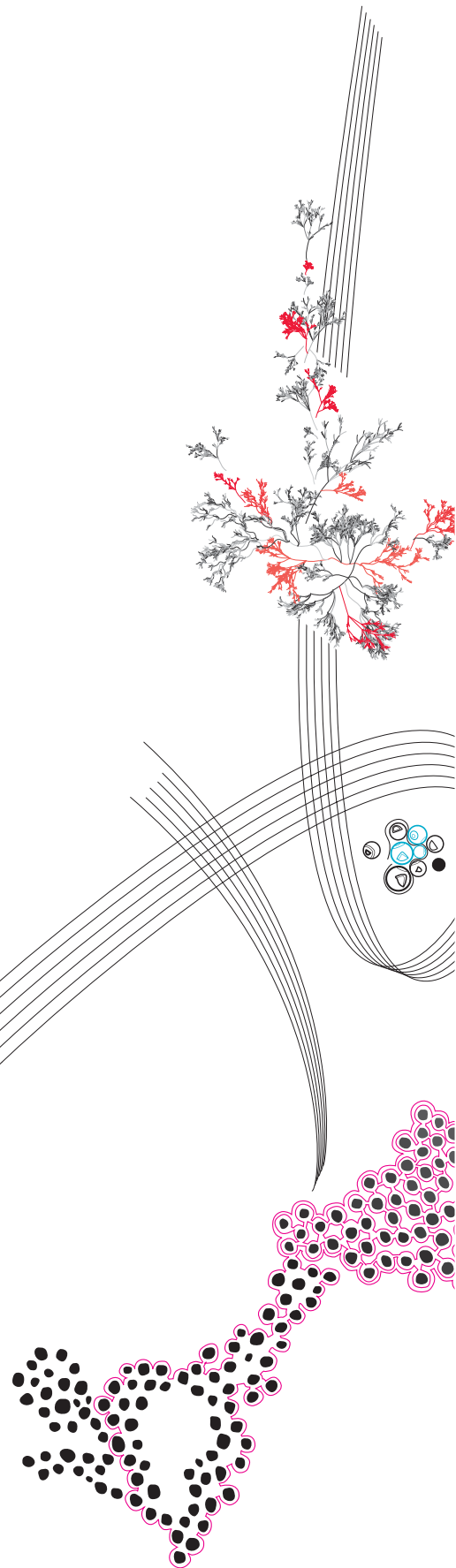BSc Thesis Creative Technology

# Designing Voice-Based Games for Children That Stimulate Physically Active Social Play

Rachel den Otter

Supervisors: dr. ir. Dennis Reidsma, MSc. Ezgi Cakir
Critical Observer: dr. Armagan Karahanoglu
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**UNIVERSITY OF TWENTE.**

**Abstract**

It is essential for young children to enjoy enough play experiences that enrich their physical development, as well as promote their social skills. This thesis explores how voice-based games can stimulate physically active social play. Through iterative design stages and creative methods, a voice agent and four voice-based games were developed. The voice agent facilitates seamless game entry and gives children control over game selection, while the games encourage movement and teamwork. To evaluate the effectiveness of the designed product, semi-structured interviews and observations were conducted with 24 children aged 4-6 during user testing. Results indicate that the product successfully promoted physically active social play, as the children were observed jumping, crawling, collaborating, and discussing game options. Despite these positive outcomes, further research is recommended to assess the long-term impact of the voice-based games and to compare their effectiveness with traditional playground settings without a voice agent.

# Acknowledgement

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# Chapter 1

# Introduction

Everyone has been a child once, which means we all know what it is like to explore the world through the eyes of a child. Since we have little obligations, a large part of our time is spent playing. According to the UN Committee on the Rights of the Child (CRC, 2013) "children's play is any behaviour, activity or process initiated, controlled and structured by children themselves".

Play is crucial to children's development. It is through play that children explore, learn, and develop crucial skills like problem-solving, creativity, and social interaction (Mcmahon, 1992). Specifically, physically active play facilitates the release of energy and promotes improved focus in educational settings, with research indicating positive correlations between physical activity and academic performance (Álvarez Bueno et al., 2017). However, in recent years, there has been a noticeable decline in the physical activity levels of children. Sedentary lifestyles, increased screen time, and a lack of safe play spaces contribute to this trend. According to the World Health Organization (WHO, 2022), insufficient physical activity is a significant concern, with over 80% of adolescents not meeting the recommended levels of physical activity. This lack of movement has serious negative consequences, including increased rates of childhood obesity, poorer mental health outcomes, and a higher risk of developing chronic diseases such as diabetes and cardiovascular issues (Janssen & LeBlanc, 2010).

Social play, occurring when two or more children play together, fosters friendship formation, empathy development, and cooperative behaviours (Whitman, 2018). The primary school years provide ample opportunities for such social interactions, particularly when coupled with physical activity, enhancing the overall benefits derived from play experiences. Unfortunately, not all children have equal access to social play. Some children don't know how to ask to join, while others are purposely excluded by the group.

Voice agents could play a role in solving these obstacles and help involve all children in physically active social play. Voice agents or Voice User Interfaces (VUIs) are interfaces that oblige the user to give commands and interact through speech (Kakade, 2018). Research from Pantoja et al. (2019) has concluded that voice agents can effectively assist high-quality social play by keeping players engaged socially. This project will seek ways to improve play situations for children and stimulate physically active social play through the creation of voice-based games. The main research question guiding this project is:

**RQ**: How can voice-based games effectively encourage children to participate in physically active social play?

This document will guide the reader through the process of answering that question through sub-questions. Chapter 2 provides background research, including a literature review on children's play and challenges faced in play, establishing a context where voice agents can help overcome barriers. This relates to the first sub-research question:

**Sub-RQ 1**: What are barriers that keep children from playing?

The background research chapter will also dive into the literature on how children interact with voice agents to answer the second sub-research question:

**Sub-RQ 2**: How can a voice agent be designed to facilitate communication with children?

Lastly, the background research reviews existing reference work on promoting physical activity and/or social interaction through (voice-based) games, answering the third sub-research question:

**Sub-RQ 3:** How can games promote physical activity, social interaction and fun?

Following the background research, Chapter 3 introduces the Creative Technology Design Process (Mader (1) & Eggink (2), 2014) and the techniques used, shaping the rest of the report through ideation (Chapter 4), specification (Chapter 5), and realisation (split into Chapters 6 and 7). To evaluate the project, we will assess how children interact with the designed voice agent and games and measure the extent to which the desired goals are achieved, answering the final sub-research question:

**Sub-RQ 4**: Is/Are the designed voice-based game(s) effective in stimulating play?

Chapter 8 describes the user testing methods utilised to answer this, with the results presented in Chapter 9. Finally, the discussion and conclusion chapter summarises the findings, discusses limitations, and suggests implications for future research.

# Chapter 2

# Background Research

This chapter will present research into relevant literature and related work to establish a context for enhancing play with voice agents.Through a literature review, the first sub-research question will be addressed, identifying types of play found in literature and barriers hindering children's participation. Additionally, the chapter will examine how voice agents can be designed to meet children's needs and preferences. Finally, it will analyse related work also focusing on reducing social barriers or promoting physically active play through voice-based games designed for children.

## 2.1 Play: Types and Barriers

Literature research has been performed to come up with a play context for this project. This was done for the Academic Writing course within the Creative Technology graduation semester and is partly shown here for its relevancy to this project. Before delving into the findings of the literature review, the next section will explain the methods employed for finding relevant literature.

### 2.1.1 Literature Research Methods

The databases Scopus, ACM library and Google Scholar have been used to find academic literature. Scopus and ACM Library were chosen for their extensive collection of peer-reviewed publications, with ACM Library particularly focusing on information technology. Google Scholar served as a supplementary resource, accessed either when publications of interest were unavailable through the other databases or for broadening the search scope. Table 2.1 presents the keywords and search queries used per topic. Most keywords were identified through an initial exploration of early literature on the subject, supplemented by input from the thesis supervisors.

TABLE 2.1: Methodology for literature research on play

| Topic | Keywords | Search queries |
|---|---|---|
| Definitions of play | defining, play, definitions | <ul><li>*Article title:* definitions OR definition OR defining AND play</li><li>*Article title:* children AND play AND definition OR defining</li></ul> |
| Types of play | cooperative, inclusive, symbolic play, pretend play, sociodramatic play | <ul><li>*Article title, Abstract, Keywords:* children AND cooperative AND fun AND play AND NOT autism AND NOT autistic</li><li>*Article title, Abstract, Keywords:* children AND cooperative AND inclusive AND play</li><li>*Article title, Abstract, Keywords:* "types of play" AND schoolchildren OR children</li><li>*Article title:* children AND cooperative AND play</li><li>*Article title:* primary AND school AND children AND play</li></ul> |
| Challenges in play | non-participation, shyness, obstacles, reticent behaviour, behaviourally inhibited | <ul><li>*Article title:* Non-participation AND play</li><li>*Article title:* behaviorally AND inhibited AND children</li><li>*Article title, Abstract, Keywords:* Reticent AND behavior AND children AND play</li><li>*Article title, Abstract, Keywords:* shyness OR obstacles OR barriers OR hindrances AND children AND play</li></ul> |

### 2.1.2 Literature Review

This literature research aims to identify obstacles in children's play that the to-be-designed games could help overcome. The main question is: what are the social challenges experienced by primary school-going children during play? This review looks for a definition of play, explores different categorisations of play and addresses social challenges in play.

**Definitions of play**

To identify categorisations of play and consequently find challenges in play, it is crucial to first establish a definition of play. In the introduction (chapter 1), the definition of the CRC (2013) has been included describing play as an activity or act initiated and controlled by children themselves. Although this gives us an idea of everything that can be considered to be 'play', it is not very specific and implies that only children can play. The definition is not per se false, but it suggests that there might be more ways to define play and one might not necessarily be correct or incorrect.

Two key characteristics come forward when reading literature that tries to define play. The first characteristic that is identified is the fact that play is done voluntarily and for fun. Gordon (2008) defines play as a "voluntary movement across boundaries". She elaborates that this movement "releases tension in pleasurable ways" just like Brown and Eberle (2017) acknowledge that the activity in which children are absorbed during play is one that "provides enjoyment". Wing (1995) explored children's own perspectives on play, specifically their idea of what activities they would define as play and what would be considered work. The main findings likewise show that in the children's eyes play is something they get to do while work is something they have to do.

Furthermore, the literature seems to agree that play is per definition purposeless or done for its own sake. Where Brown and Gordon straightforwardly note that it is a precondition of play to be done "for its own sake", Sicart (2014) defines play as "an autotelic activity that fulfils its goals, purposes and conditions by itself". Schmid (2011) however, pleads to move beyond autotelic as a definition, and rather look at "Intrinsic Reasons". His argumentation behind this is based on the fact that autotelic play is a complex concept explained in varying ways with most explanations being a mixture of variations, making it hard to comprehend. By looking at intrinsic reasons there is still the idea that there is no extrinsic motivation to play but that the desire to play is evident by nature. So even though there may be a debate between the wording of intrinsic values or autotelic actions, at the core of play lies the absence of a distinct purpose. To conclude, without necessarily defining play as an activity, movement across boundaries or a state of mind it is the inherent essence of play that it is something that is done voluntarily and without extrinsic purpose.

**Categorising types of play**

Moving from the identification of what is and what is not play, the focus will shift towards a more concrete look at categorisations and types of play mentioned in literature. In literature, there are many different types of play discussed, such as sensory

play, competitive play, parallel play, symbolic play, imaginative play, and many more. These have been arranged in various ways to form categories of play. This section will highlight two primary play classifications made by founding psychologists and demonstrate how these have been used and modified by later works.

Feldman et al. (2020) categorize play based on its goal into functional (repetitive activities) and constructive (building with materials). Piaget identified functional, constructive, fantasy play, and games with rules (Van Hoorn et al., 2015). Ethridge et al. (2022) added guided play, combining free play and adult mentoring.

The second main categorisation is from Mcmahon (1992), who classifies play into physical, sensory/creative, social, exploratory, and symbolic/pretend categories. Robins et al. (2008) adapted this to sensory-motor, symbolic, constructive play, and games with rules. Recent studies added more categories, such as pretend and socio-dramatic play (Ashiabi, 2007), role play, digital games (Veraksa et al., 2022), and physical play with objects (Scheepmaker et al., 2018).

Table 2.2 shows an overview of these categorisations found in literature.

TABLE 2.2: Categorisations of play found in literature

| Who | Categories |
| --- | --- |
| Feldman et al. (2020) | functional and constructive play |
| Ethridge et al. (2022) | functional, constructive, fantasy play, games with rules, guided play |
| Mcmahon (1992) | physical, sensory, social, exploratory and symbolic play |
| Robins et al. (2008) | sensory-motor, symbolic, constructive play and games with rules |
| Ashiabi (2007) | pretend, rough-and-tumble, socio-dramatic |
| Veraksa et al. (2022) | role play, digital games, games with rules |
| Scheepmaker et al. (2018) | physical, play with objects, symbolic, pretend, games with rules |

These classifications suggest there are connections to be made between the different sources and their identifications of play types. For example, symbolic play often refers to the same behaviour as (socio)dramatic or pretend play. As described in chapter two, Schmid (2011) argues we should look at play as intrinsic reasons. This not only supports the notion that it is voluntary and purposeless, but it also makes it possible to connect pretend play with dramatic play to an innate need to pretend. A novel method of classifying play is hereby found by establishing intrinsic values to link different play kinds, as indicated in Table 2.3.

TABLE 2.3: Intrinsic values to allocate to play

| Intrinsic value | Skills developed |
| --- | --- |
| to explore | observation skills |
| to pretend | imagination, fantasy |
| to solve problems | improvisation, flexibility |
| to construct | fine motor skills |
| to release energy | gross motor skills |
| to feel sensory stimulated | senses, appreciation |
| to feel motor skilful | confidence, motor skills |
| to relate | social skills |
| to express emotions | emotional intelligence |
| to have a sense of identity | self-awareness |

Next to that, there are also contextual aspects to consider, as shown in the list below. By indicating these contextual characteristics an extra layer of specifications is added to the categorisation.

1. structured or unstructured
2. free or guided
3. solitary or parallel or onlooker or associative

These two lists provide a categorisation system for play and can assist in the creation of voice-based games for the graduation project. By combining intrinsic values and picking a context, as shown in images 2.1 and 2.2 many play types can be constructed to support the game design process.

**Social challenges experienced in play**

From the first sections, it is evident that there are many different ways to describe and categorise play, underscoring its multifaceted nature. Understanding the diverse forms of play lays the groundwork for comprehending the challenges inherent in supporting active and social play experiences. In this next section, we will delve into the social challenges experienced in play as documented in the literature, recognising that these challenges may also vary across different play contexts and categories.

Two types of social barriers come forward in the literature. The first is intrapersonal barriers, where the obstacle comes from the child's psychological state (Bergstrom, 2019). These challenges include stress, anxiety and feeling overwhelmed. Veiga et al. (2017) write that solitary behaviour can have distinct impacts on the process of becoming disconnected from one's peer group. They also noted that instead of engaging in solitary play, reticent behaviour was prevalent in preschoolers' play. On average, more than a quarter of the children's free time was spent observing others while remaining unoccupied themselves. Han and Tobin (2023) write about this same reticent behaviour as they applied Benjaminian concepts to children's non-participation in play. They looked at four types of non-play behaviour, namely bewilderment, anticipation, resistance and attention and questioned why so many play activities are arranged like shops in a mall, with an excessive amount of options for children to choose from. They argue that children become flâneurs as they can not keep up with
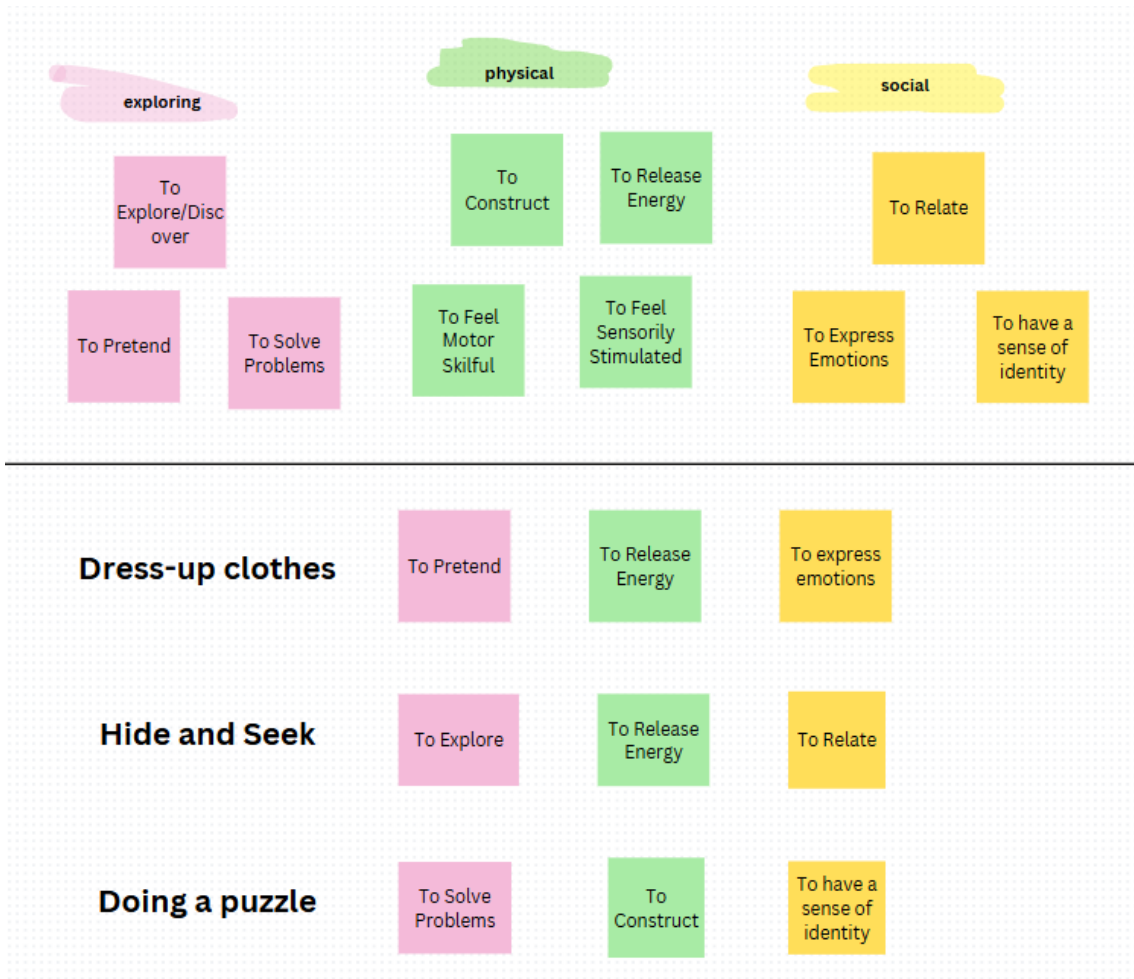
FIGURE 2.1: Combining intrinsic values to create play types
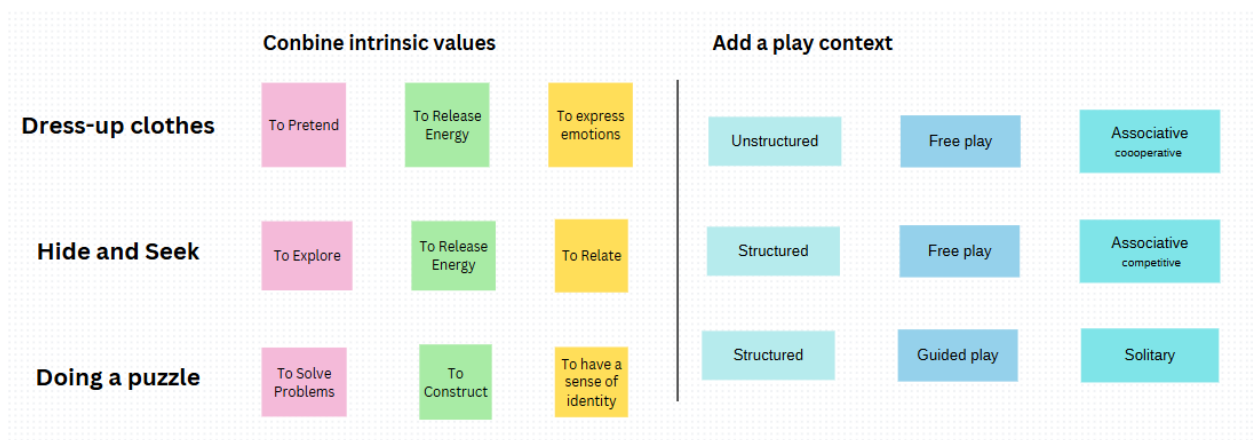


FIGURE 2.2: Play can be constructed from intrinsic values and a play context

what is going on in the classroom, while there are alternatives like whole-class activities that encourage more social interaction among children.

Next to intrapersonal barriers, Bergstrom also describes interpersonal barriers which concern obstacles as a consequence of interpersonal communication and/or relationships. Getting excluded by other children can be an apparent example of this, however, there are also less obvious examples, like Bodrova and Leong (2019) describe. They write about the issue of having children be in a classroom with children of the same age all having equally immature play skills. This would provide a sub-optimal play environment as there is no possibility of learning from older experienced peers. Challenges can also occur in the play between adults and children as adults encounter the effects of a "remote control childhood", described by Levin (2010) as experienced by adults who grew up from the 1980s onwards who have spent a lot of their childhood with screens, limiting their creative free play time. Understanding both intrapersonal struggles like stress and reticence, as well as interpersonal barriers such as exclusion, is crucial for fostering enriching play environments.

**Conclusion**

This review aimed to shed light on what play is, how to categorise it and what social challenges occur in play. Defining play reveals its voluntary and purposeless nature, aiding in categorising play based on intrinsic values. The found intrinsic values form a framework for designing games for this graduation project.

Next, the division of play barriers into interpersonal and intrapersonal helped in understanding the social complexities in children's play experiences. By focusing on social challenges, such as social anxiety and decision numbness, areas where voice agents could potentially mitigate obstacles and promote social play have been identified.

Given all this, it is clear that to design effective voice-based games, personal involvement and manageable play contexts are crucial, as well as exciting intrinsic values. However, every child is different, necessitating further research into practice-based playground situations.

## 2.2   Technology: Voice Agents

In addition to scientifically supporting what obstacles can be identified in play, the idea that voice agents can assist in dismissing these obstacles will have to be backed up. Various studies have already explored children's interactions with voice-based conversational agents, revealing the potential for stimulating play relevant to this project. Pantoja et al. (2019), for example, discloses that voice agents can be used to enhance high-quality social play through the promotion of social interactions and the redirection of activities towards role-play. Moreover, voice agents are ideal for children who cannot read or write yet and are in general more straightforward to interact with than mobile devices, which typically require visual and manual attention. This section will delve deeper into the literature examining the intersection of voice technology and children's engagement in play.

### 2.2.1 Literature on Voice Agents for Children

Given the apparent potential of voice agents in this domain, numerous studies have outlined design guidelines for developing voice agents tailored to children. For instance, Xu et al. (2021) conducted research on whether voice interfaces can support shy children in their language development. Their study involved selecting applications from platforms such as Amazon Alexa and Google Assistant and coding these on their initiation prompts and the solicited user feedback. Based on this analysis they derived the following four design implications;

1. Incorporate open-ended questions while preserving the ability to provide meaningful feedback.

2. Incorporate feedback that extends a child's utterance to enable more in-depth multi-turn dialogue on a single topic.

3. Utilize design strategies that encourage children's language production, in particular, for those children who are hesitant or unwilling to respond.

4. Recognize the need for more nuanced scaffolding that adjusts to children's differing response patterns.

Garg and Sengupta (2020) established design recommendations following three design sessions dedicated to understanding children's preferences regarding the utilization of voice agents. While their primary focus was on the integration of voice agents for in-home learning, their findings offer valuable insights into children's communication preferences with voice agents and the factors that engage them.

1. Support different learning modes, roles and personas to offer personalizing based on the user's skills and interests.

2. Include human-like characteristics, like adaptability based on context, being able to sense and express emotions and to converse like a human as much as possible.

3. Foster social interaction and engagement by integrating features that facilitate the participation of multiple family members or friends in children's interactions with the device.

4. Provide control to parents by incorporating functionalities that enable parents to establish learning objectives and monitor and restrict the children's use and progress.

While supporting various learning modes may not be directly relevant to this project, offering personalisation through roles and personas can be helpful to attract the children's interest. It is, however, important to note that not all roles are suitable for interaction with children, and some, such as those mimicking individuals from their trusted network, can evoke fear (Yip et al., 2019).

Lastly, Pantoja et al. (2019) did background research on voice agents for the Story Carnival project, which will be discussed in more detail as part of the related work in

Section 2.3.4. Their study found design recommendations for the ideal voice agent for children, focusing on facilitating high-quality social play. Through play sessions where children tested different voice agents, they analysed children's behaviour and composed a list of design implications.

The first area of focus considered is the looks and embodiment of the voice agent. The study found that children prefer a portable and tangible voice agent, over one that is screen-based or not transportable. Additionally, giving physical representations of a character proves effective for setting social expectations. These representations do not have to be detailed, even a static facial expression made the children relate to them affectionately. For instance, children tended to show more warmth in their interactions with the cat-like voice agent compared to one resembling an archetypal robot.

Moreover, focus has been placed on exploring the desired mode of interaction for a voice agent. This led to the conclusion that voice agent interventions are likely to work best when they make suggestions and provide positive reinforcement for behaviour that fits high-quality social play. Examples of this would be collaborating with a peer or re-engaging with the storyline. Next, Voice agents should attempt to be polite towards children and avoid authoritative speech. It was also found that touch-screen interfaces distracted from the main purpose, while physical props helped to keep the children engaged.

## 2.3   Related Work

This section focuses on finding work that exemplifies ways to promote social interaction, physical play and engagement in (preferably voice-based) games. To direct our search within the scope of our project, three main aspects of the project have been visualised in Figure 2.3.



FIGURE 2.3: Visualisation of the three subtopics for the related work

This figure shows two overlapping areas, with on the one hand physical play and our knowledge of how voice agents can stimulate this and on the other hand literature on developing social play and the way voice agents can decrease social barriers. As there was no existing voice-based game found that aimed to both omit social barriers

in play, as well as stimulate physical activity, the related work will consist of work that combines at least one of these aspects with voice-based technology.

This section will commence with examples that combine the middle and left circles, as voice-based games that stimulate physical activity are explored. Specifically, a selection of games from Amazon's Alexa Skills platform and a podcast series for children called Lingokids will be considered. Next, the relevance of the Toniebox, a device focusing on screen-free audio play, will be addressed. Lastly, work focusing on social play that omits personal barriers in play is discussed. For this, we take a closer look at two projects from literature called Story Carnival and Playground Architect.

### 2.3.1 Alexa Skills Games for Children
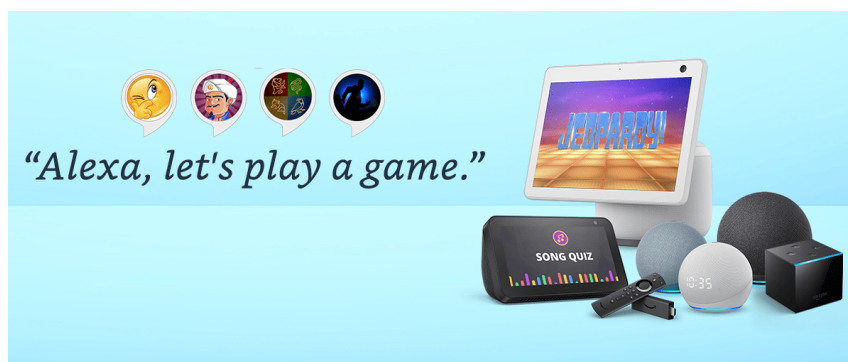


FIGURE 2.4: Alexa Skills offers a broad range of voice-based games

Amazon's Voice Assistant, Alexa, offers a variety of voice-based games through a collection known as Alexa Skills. Alexa's kids' platform features games specifically designed for children, categorized into 17 groups, including educational games, party games, role-playing games, and card games. Among these, several games promote physically active play.

One such example is "Wiggly Kids", which uses interactive voice and music tracks to prompt physical activities. Children are encouraged to act out commands like "Let's stomp like an elephant" or "Can you run like a cheetah?" followed by doing fitness moves such as jumping jacks and air punches. Another game, called "Freeze Dance", lets children dance to kid-friendly beats and challenges players to freeze when the music stops. It includes musical storylines that guide children through themes like the alphabet or the rainforest, combining movement with educational content.

These examples illustrate how voice-based technology can effectively engage children in physically active play through interactive and imaginative commands in combination with music and sound effects.

### 2.3.2 Lingokids Podcasts
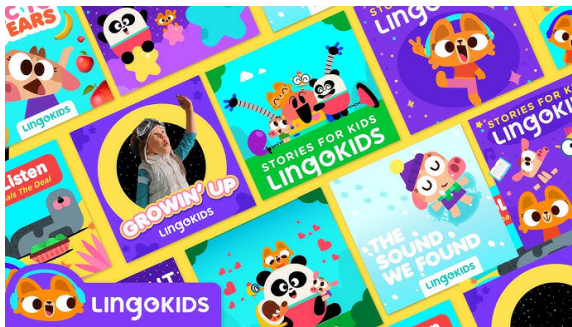


FIGURE 2.5: Lingokids podcasts

Lingokids is a mobile app for children's play and learning, which has been awarded the number one kids learning app in 2022 and 2023. Next to games to play on a mobile phone, it offers podcasts that stimulate audio-based play and learning. On their website, they describe Stories For Kids, which are interactive stories in which children interact with characters and puzzle out problems. In another type of podcast called Music To Our Ears they motivate children of the ages 2 to 5 to sing and dance along to music while they learn about fun, easy-to-understand facts.

### 2.3.3 Toniebox

The Toniebox is an audio system designed to provide voice-based play, empowering children to control their storytelling experience. By placing a Tonie figure on top of the box, children can select and listen to their favourite stories, fostering a sense of autonomy and decision-making. Its portability allows for use in various settings, from playrooms to outdoor environments, encouraging physically active play as children can move and dance to the music and stories. The simplicity of the Toniebox interface, devoid of screens and complex controls, en-



FIGURE 2.6: The Toniebox

sures that children can engage with the device independently. It exemplifies how autonomous use and options to pick stories of one's own liking help to get children engaged in audio-based play.

### 2.3.4 Story Carnival

Researchers from the University of Iowa have developed a system that supports pretend play through e-book stories, a play planning app and a voice agent. One of the main goals of the research is to empower shy children to more confidently engage with their peers. They developed a voice agent called MiniBird, which is adult-controlled and focuses on keeping children engaged during play.

FIGURE 2.7: Intro screen on the Story Carnival site



FIGURE 2.8: The voice agent MiniBird

The work by Pantoja et al. (2019) on how voice agents can support high-quality social play has already been described in Section 2.2.1. That work served as background research for the creation of Story Carnival and its voice-agent MiniBird. Based on this research, Hope Currin et al. (2021) looked into the comparison of how StoryCarnival and its designed voice agent promotes Tools of the Mind Play against the traditional Tools of the Mind curriculum without technology. The study found that voice agents like MiniBird are a great tool to support shy children and help them engage in pretend play. The advantages of MiniBird include children feeling responsible for MiniBird and wanting to take care of its needs and MiniBird allowing children to focus on physical aspects of play, rather than a screen or static agent. Voice agents can also redirect distracted children to keep them engaged, by talking to them. The fact that MiniBird did not have to take a central role in the play, but allowed children to take the play into their own hands based on a suggestion indicates that voice agents can also support collaborative, creative and physical play activities.

### 2.3.5 ColorFlares

The ColorFlares offer an example of a play object that focuses on physically active social play. Bekker and Sturm (2009) describe the design case for these physical flares that detect movement and give feedback by lighting up in different ways. Their research explored how the success of non-interactive open-ended play objects, such as Lego or a standard ball, could be translated into interactive open-ended play items. Their findings highlight that providing feedback on physical activity stimulates physical play. Additionally, they vouch for open-ended play, which allows children to create play significance by coming up with games and rules, thereby stimulating social play. Their user



FIGURE 2.9: Children playing with ColorFlares

tests also note that children enjoyed open-ended play as they came up with many different games.

### 2.3.6 Playground Architect

Playground Architect is a multiplayer game around an interactive tabletop surface designed to help shy children gain social confidence. There is no voice agent and the game is not voice-based, but it provides a particular example of a social game that diminishes barriers. Hendrix et al. (2009) describe the design and evaluation of this game in which shy children are assigned a leading role. In the game shown in Figure 2.10, children work together to build a playground on an interactive tabletop surface. In this process shy children take control and other children take the role of builder, taking orders from the so-called architect.



FIGURE 2.10: Playground Architect's interactive tabletop

32 children (mean age 9.5) participated in the evaluation of the design study which showed that all players took pleasure in playing the game. Most importantly, results showed that peer acceptance increased after playing the game and 6 out of 8 supposedly shy architects reported positively on being in charge. They also spoke equally as much as the other children and their teachers found that they behaved more outgoing and unrestrained than usual. This study illustrates how it is possible to stimulate shy children to get out of their shells by assigning them leading roles.

## 2.4 Conclusion

Through researching relevant literature and considering related work insight has been gained into the current state of voice-based game technologies that stimulate physically active and/or social play. It has been found that play is crucial to children's

development and is triggered by different intrinsic values. Obstacles in play have also been identified and especially social barriers, like not finding ways to join play (because of social anxiety or getting excluded) can be fatal for a child's play. All of this has led to the formation of the following answers to the research questions:

**Sub-RQ 1:** Children experience stress or anxiety if they do not know how to ask to join or are scared to do so. Children can also experience decision numbness when there are too many play options and they can not decide what to do. Lastly, there is an aspect of missed competence of adults who themselves may have limited experience with creative free play and do not know how to facilitate it.

**Sub-RQ 2:** Studies have shown that having a tangible device with a minimal physical representation of a character and human-like characteristics is beneficial for interacting with children. The device should redirect activities towards social role-play or focus on giving open-ended prompts or play suggestions.

**Sub-RQ 3:** Physical activity can be promoted by giving children challenges to act out and by using music. Furthermore, providing visual or audio feedback on the children's participation stimulates them to move more. Social interaction can be promoted by giving children roles and thereby challenging shy children to participate. Engagement and fun can be promoted by giving children control over what they are going to do and offering options for different interests.

# Chapter 3

# Methods

This chapter outlines the methods employed in the project's design process. The primary framework follows the Design Process for Creative Technology as described by Mader and Eggink (2014). Additionally, the Delft Design Guide has been referenced to draw design techniques from (van Boeijen, Daalhuizen, & Zijlstra, 2020). So far this report has focused on constructing a literature overview of the challenges experienced in play and design opportunities of voice agents. In the coming chapters, various methods will be utilized to progress from these insights to a product idea that diminishes as many obstacles as possible while stimulating active social play. These methods are first described here, along with the rationale for their selection, before proceeding to their application.

## 3.1 Ideation phase

### 3.1.1 Expert Interview

Expert interviews are interviews with experienced teachers who have worked/work with primary school-going children. In a semi-structured interview, there is an interview guide with a list of prepared questions, but the interview can diverge from this if another interesting topic is touched upon. The questions form an option to fall back on or steer the conversation in a certain direction, but the main focus is to hear what the interviewee has to say about the topic.

This method has been chosen to confirm the findings of the background research and gain practical examples and solutions. By gaining insight into what barriers in play teachers see and any methods or techniques they might use to overcome these obstacles we can deduce requirements for the voice-based game design.

Contact with teachers has been established through the personal connections of the researcher and supervisor. During the ideation phase, one interview was hosted to confirm background research and gain insight into practical scenarios. These were used to draw up requirements for the final concept. After this, another interview was planned to take place to gain feedback on the preliminary requirements and written scenarios, but unfortunately this was cancelled.

| Play Setting | Role | Smartness/communcation abilities | Looks/embodiment |
|---|---|---|---|
| Shyness/social anxiety | Educator/Teacher | Non-Interactive/Pre-Recorded | Animal Avatar |
| Social exclusion/getting bullied | Entertainer/Companion | Limited Interaction | Human Avatar |
| Decision numbness IC/OC | Assistant/Helper | Basic AI Interaction | Robot Avatar |
| Not interested in others | Companion/Confidant | Advanced AI Interaction | Fantasy Creature Avatar |
| Gender stereotypes, societal expecta | Mediator/Facilitator | Human-like AI Interaction | Customizable Avatar |
| Mismatched interests | Learning Partner/Peer | | Invisible Presence |
| Cliques and group dynamics | | | |

FIGURE 3.1: Table created to support idea generation

### 3.1.2 Mind mapping

Mind mapping is a technique to graphically represent ideas and aspects around a central theme (van Boeijen et al., 2020). It can be used to identify all issues and sub-issues to a problem but also for mapping advantages and disadvantages to solutions. The first is used at the start of the ideation phase to create clarity on the problem and design opportunities.

### 3.1.3 Brainstorming

Using the play categorisation system from chapter 2.1.2, intrinsic values have been combined to think of game ideas and prompts. Hereby especially focusing on the intrinsic values "to release energy" and "to relate", as they stand at the base of physically active social play.

Next to the intrinsic values system, a brainstorm has also been performed with the help of a voice buddy creation table as shown in image 3.1. By coming up with different options for the embodiment, role of the voice agent, etc, we can match options and come up with many ideas on what the device would look like or how it would interact.

### 3.1.4 Harris Profile

At the end of the ideation phase, the design process steers towards a final approved concept to further specify. Through brainstorming, different concepts have been suggested, of which one will have to be deemed the best option for this project. In order to guide this decision-making a graphic representation that displays the strengths and weaknesses of each concept has been created in the form of a Harris Profile. Comparing and scoring the concepts on criteria from the preliminary requirements gives an overview of the problem criteria and aims to highlight one selected approved concept.

## 3.2 Specification phase

### 3.2.1 Written Scenarios

In order to delineate a conceptual idea about the interaction between users and the device, written scenarios have been created. The procedure for creating these scenar-

ios comes from the Delft Design Guide (van Boeijen et al., 2020) and is described in short below:

1. Determining actors in the scenario
2. Determining goals of the actor
3. Determining the trigger/event that starts the scenario/interaction
4. Identifying stakeholders and their interest
5. Determining the number of scenarios to be created based on the number of actors and their goals
6. Writing the scenario

## 3.3   Evaluation phase

The evaluation phase consisted of a user study with the target group. To test the product and gather the desired data two techniques have been utilised. Below an explanation of what they entail and why they have been used is provided, details on how they are used are described in Chapter 8.

### 3.3.1   Wizard of Oz

Wizard of Oz refers to the mimicking or "wizarding" of interactivity with a prototype that would normally be controlled by computer technology (Weiss et al., 2009). The experience for the user should be the same as with a fully functioning product, but the development is quicker and cheaper. This technique was chosen because the electronic implementations were not reliable enough at the time of testing and it makes the product more durable if the children break something.

### 3.3.2   Picture Task

Conducting interviews with young children necessitates creative methods to elicit the desired information. The objective of the interviews is to encourage children to discuss their play experiences, allowing for the identification of recurring themes. To gauge their perception of the voice agent, children were asked to select a picture that they felt represented the voice agent, following a method described by Wijnen et al. (2019).

# Chapter 4

# Ideation

The goal of the ideation phase is to first diverge and explore the user needs and technological possibilities, subsequently converging to a more defined product idea. In relation to this project, that means mindmaps are created, expert interviews are hosted, and brainstorming sessions are held. Using the outcomes of these creative techniques, five concepts for stimulating physically active social play with voice games are generated. These ideas will be analysed and compared, leading to the selection of one approved concept that will be realised for this project by the end of the chapter.

## 4.1   Mind map

A mind map has been created on the problem and sub-problems to create an overview of the design problem, as shown in Figure 4.1. These obstacles follow from the background literature research (Section 2.1.2) and more elaborately depict all obstacles found, rather than a small selection of social obstacles. The mindmaps show areas to focus on and keep in mind for the idea generation.
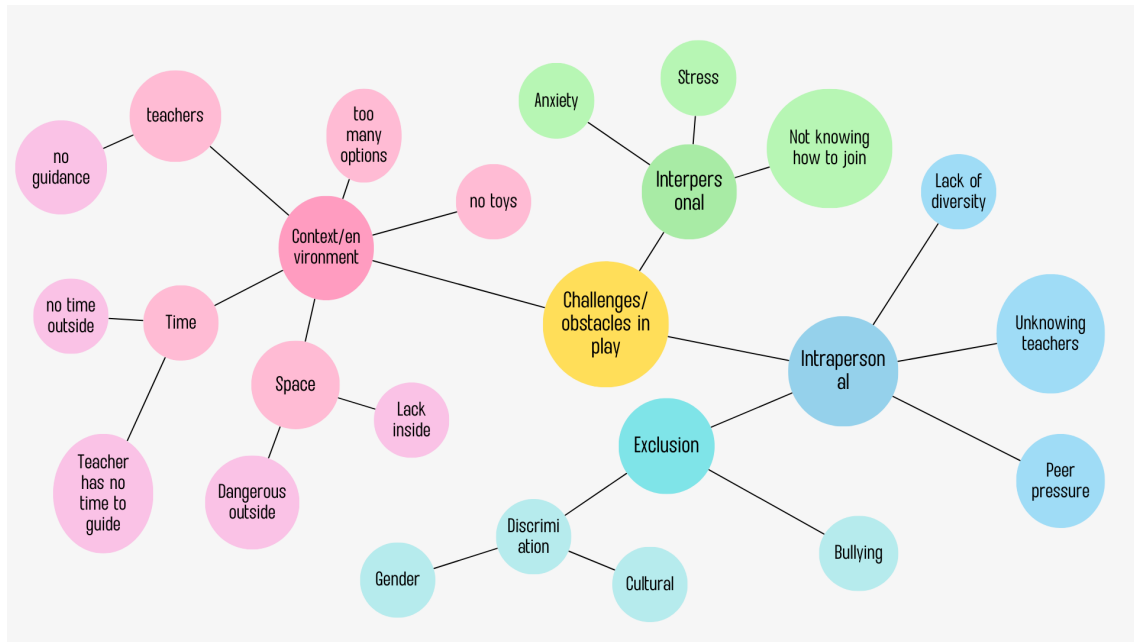
FIGURE 4.1: Overview of the obstacles to play in a mind map

## 4.2 Expert Interview

As part of the ideation phase, an expert interview with a primary school teacher has taken place. The teacher has more than 13 years of experience in teaching children aged 4-12 in different primary schools. This interview provided interesting insights into how teachers see play and handle obstacles in play during school time.

The main takeaways from the interview have been summarised and are listed below.

1. There is no fallback option for children if they do not understand a game. Without an easy way to step back, they can fall behind or opt out.
2. The children enjoy playing games with the whole class on the interactive whiteboard, taking turns to come to the front and interact with it. While everyone seems to enjoy this, some children need extra support from the teacher to participate.
3. If a child is not actively involved in physical dancing or moving activities done with the whole class, a teacher can motivate them with words or literally take them by the hand and do it together.
4. Sometimes children are excluded from play by others. Simply saying "share together, play together" works well with the preschoolers.
5. Children often play with the same set of friends, even though there is much to learn from older, more experienced children.
6. Teachers can benefit from the support of a voice agent in the doll corner. They often do not have time to guide pretend play, even though it is important for the children's development. Children are encouraged to use class themes but may need guidance to cover themes like 'museum', helping them understand what happens in a museum and how it can be re-enacted.

7. Most parents are unhappy when their children spend school time sitting behind an iPad or computer screen. They do not want too much screen time and prefer to manage it at home.
8. Electronic devices should be made sturdy to withstand falling and rough play.

## 4.3 Preliminary Requirements Elicitation

Upon reviewing the background information and conducting expert interviews, initial design requirements emerge. These are delineated from two principal aspects: the voice agent as the primary entity and the games accessible via the voice agent. Presented below are the preliminary requirements related to the voice agent with in brackets the source section they were acquired from.

1. **Portability and Tangibility**: The voice agent is portable, allowing it to be easily moved to different locations where physical activity can take place. It has a tangible presence, making it easy for children to interact with. (2.2.1)

2. **Durability and Loudness**: The device is sturdy and robust to withstand physical activity and potential drops. Additionally, it has a loud and clear audio output to ensure instructions and feedback are easily heard, preferably with adjustable volume. (4.2)

3. **Minimal Physical Representation**: The voice agent has at least a minimal physical representation, such as resembling a buddy, animal, or fantasy creature, to help children relate to it and engage with it as a companion during gameplay. (2.2.1)

4. **Personalized Interaction**: The voice agent should be capable of addressing children personally, using a nickname or other identifiers, to keep them engaged and foster a sense of connection. (4.2)

5. **Feedback on Physical Activity**: Preferably, the voice agent offers real-time feedback on the physical activity performed by the players. This feedback can include encouragement, sound effects or suggestions for improvement. (4.2)

Next to the voice agents, games will be designed to play with the voice agent. The following preliminary requirements have been drawn for the games:

1. **Easy Joining to Promote Inclusiveness**: Games allow for seamless joining to reduce barriers for children who may experience obstacles such as anxiety or fear of not knowing the rules. (2.1.2)

2. **Open-Ended Gameplay**: Games provide open-ended gameplay experiences that encourage creativity, exploration, and social interaction. Avoid rigid structures or predefined outcomes to allow for diverse playstyles and outcomes. (2.3.5)

3. **Discovery of Topics**: Games enable children to discover topics they enjoy through gameplay. This could involve incorporating educational elements, exploration of different themes, or opportunities for self-expression. (2.3.3, 2.3.2)

4. **Variety of Physical Activities**: The games incorporate a variety of physical activities into gameplay to cater to different interests and abilities. This can include activities such as running, jumping, dancing, stretching, or imaginative play. (4.2, 2.3.1)

5. **Social Engagement**: The games foster social interaction among players through cooperative or competitive gameplay mechanics. Encourage teamwork, communication, and collaboration to enhance the social aspect of the experience. (2.1.2)

## 4.4 Concept Generation

### 4.4.1 Games

As described in Section 3.1.3, brainstorming techniques have been performed to generate ideas. In practice, this meant sticky notes were used to generate a multitude of ideas. The session started with a focus on play themes that can appeal to children. The expert interview clarified how play is often related to the themes treated in class and gave some examples, like visiting the museum or the seasons of the year. Next to those, themes from popular children's shows or toys like space, cowboys or dinosaurs, were added. These are shown in yellow in Figure 4.2.

Consequently, the focus shifted to stories to re-enact or games that could work in a voice-based setting. This is where ideas like doing a yoga lesson or re-enacting going on holiday emerged as shown in green in Figure 4.2. Here, the structuring of play through the intrinsic reasons technique (Chapter 2.1.2) was utilised in a reversed manner; by combining less obvious combinations of intrinsic values the construction of creative play ideas was stimulated.

Lastly, physical activity and a collection of physical movements that could be incorporated into games were written out. Here the focus was placed on coming up with as many movements as possible in a short amount of time. These movements are shown in blue in Figure 4.2. After having come up with a large amount of ideas on these three areas combinations were made by linking a theme, game and multiple movements.

### 4.4.2 Voice Agent

With ideation on the voice-based games done, the question remains what the voice agent would look like and how it would facilitate these games. Ideation for the voice agent meant coming up with different settings and ways the voice agent can support play. Five alternatives for the voice agent have been written out. In the end, a Harris Profile has been created with the preliminary requirements to compare the alternatives for the voice agent's design.

#### 1. Movement Sensing Voice Agent

A voice agent that consists of a motion tracking sensor that can track people standing in front of it and their movements. The device can give feedback based on how active
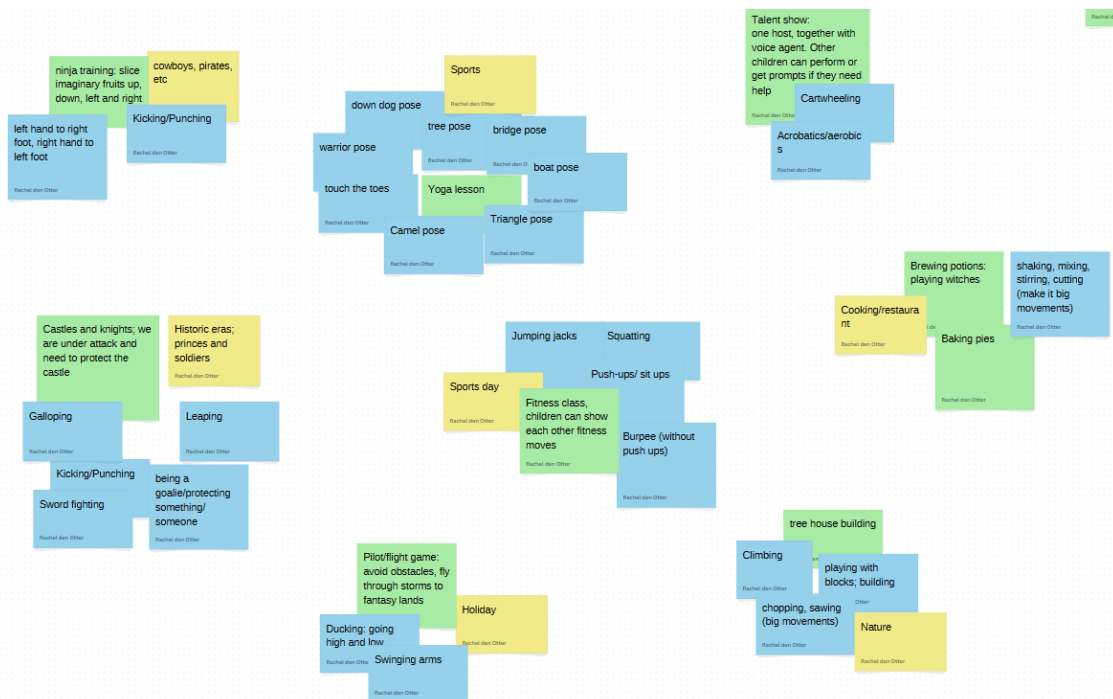
FIGURE 4.2: Screenshot of some of the combinations made with the theme, game and movement sticky notes

the movements are and might recognise movements like waving or punching/kicking and play sound effects based on movements to stimulate open-ended play.

**2. Tap-in/Tap-out Play Buddy**

The voice agent represents a character and presents itself as a play buddy. Children can join or leave play by tapping in with a character. The children can from then on be referred to as their character by the voice agent. This way, players remain engaged and can be personally addressed through a nickname.

**3. Social Facilitator Pole**

A static sturdy pole on the playground. The pole can be the starting point for all sorts of playground games, like cat and mouse, Simon says or statues. When children turn on the device, it can make suggestions for play or children can call for a specific game. The voice agent will accommodate the game through loudspeakers and is accessible for everyone to join in. The voice agent can also motivate children or assign random teams for games to make sure children mix who they play with.

**4. Transform the playground**

The voice agent is an app on a mobile device. The game starts centred around the app that gives a story for context (are they in the jungle, in a candy factory, toy store) and it divides roles. Based on roles children have to decide on important places (a tree can be the check-out for the toy store, or the boxing place for candy). Taking turns

| | Concept 1 | Concept 2 | Concept 3 | Concept 4 | Concept 5 |
|---|---|---|---|---|---|
| Portability and Tangibility | | | | | |
| Durability and Loudness | | | | | |
| Minimal Physical Representation | | | | | |
| Personalized Interaction | | | | | |
| Feedback on Physical Activity | | | | | |
| Easy To Comprehend/Control | | | | | |

FIGURE 4.3: Harris Profile of the five concepts

the children can decide on a physical prompt that will symbolize what the voice agent describes. After that, the voice agent can give prompts on what to act out/explore.

**5. Talking Play Ball**

The voice agent is a sturdy ball with speakers. It can be thrown around by children over short distances. The voice agent makes sure everyone is actively engaged in the gameplay; it can give commands about who to throw it to (the shortest, tallest, one with the best haircut) or what to act out. Anyone can join in as the ball has a facilitator role, but doesn't care about who is playing, so children can join in without feeling they have to ask.

**Harris Profile**

In order to compare the generated ideas, a Harris Profile has been created with the preliminary requirements. Figure 4.3 shows the five concepts in the order they are listed and rates them on their compliance with the requirements.

From this comparison, it is evident that each idea has distinct strengths and weaknesses. The movement-sensing voice agent (Concept 1) offers an intuitive experience with immediate feedback on physical activities. In contrast, the second concept excels in personalised interaction and only scores badly on providing direct feedback. Overall, the second concept performs the best, as it aligns well with the first four requirements. Although it lacks real-time feedback on physical activity, this can be simulated by assuming the children are following instructions and praising them for participating, similar to the way TV shows like "Dora the Explorer" simulate interaction by asking questions and pretending to engage with the children.

# 4.5 Approved Concept

As the Harris Profile supported the choice of the second concept, this has been picked as the approved concept. Below is a more refined explanation of the different aspects that the voice agent entails.

## 4.5.1 Embodiment

The voice agent's design looks like an animal or human avatar that is tangible and portable. Children can choose a character to play as and select stories or games to

engage with. This selection can be made through a button, 3D print, or other mechanisms, as voice feedback would be too complex. When a child finishes playing, they can tap out.

### 4.5.2 Settings

Players choose a character referring to a nickname, which the voice agent will use to address them. They place the character on the device or tap it, receiving feedback to confirm their participation. Additionally, players can select a story or game through prompts like cards or puppets.

### 4.5.3 Games/stories

The voice agent offers activities, such as dance, aerobics, yoga classes, and physical training exercises. Interactive stories are also available, encouraging children to reenact parts of the narrative with significant physical movements.

### 4.5.4 User Feedback

The voice agent keeps children engaged by speaking to them and calling their nicknames. It can give rewarding comments and feedback to the whole group without actually knowing how they are performing. It is essential to consider children's abilities and ensure that the feedback encourages good behaviour without making the children feel bad if they are not managing to perform the asked task.

# Chapter 5

# Specification

In this chapter, the specification of the design will follow. First, the target group is specified, focusing on primary school-aged children, particularly those aged 4 to 8. Next, the play context is explored through written scenarios that illustrate how the voice agent will be used in different settings. Finally, the design components of the voice agent are described, including the embodiment of the voice agent, the tap-in system, and the method for selecting games.

## 5.1   Specification of Target Group

The project has thus far centred around primary school-aged children. Background research lacked specificity regarding the age group selection, broadly encompassing children aged between 4 and 12. Moving forward, the project will narrow its focus to a more precise target group, accommodating the developmental abilities and skills pertinent to that particular age range. The decision has been made to concentrate on the lower age groups of primary school, specifically ages 4 to 8, and will be based on typically developing children within this range. The design objectives include providing a diverse array of interests to appeal to as many children as possible within this demographic.

The chosen target group of children aged 4 to 8 encompasses a crucial developmental stage marked by significant variations in both social and physical skills. At age 4, children typically demonstrate emerging social abilities, such as basic cooperation and parallel play, alongside foundational motor skills necessary for physical activities. As they grow up towards age 8, these skills become more refined, with an increasing capacity for teamwork, communication, and complex physical coordination. However, it's important to note that individual differences within this age range are pronounced, with some children exhibiting more advanced skills while others may still be developing foundational competencies. By designing games that cater to this broad age range, younger children can benefit from observing and learning from their older counterparts. This way the play encourages skill development across various stages of childhood.

## 5.2 Specification of Play Context

The play context consists of the question of who is there during the play, and broadly where the play takes place. The play context chosen for the voice-based games focuses on a play setting with enough movement space. This can either be outside on the playground or inside in a large enough area, like a school gym. Having the voice agent inside ensures the optimal functionality of the voice agent amidst reduced ambient noise and minimized risk of damage due to playground violence. Nonetheless, outside placement allows for creative play with natural objects, like tree branches or rocks turning into game prompts.

The play with the voice agent can be unsupervised as the voice agent can act as a mentor, providing direction, and feedback, and fostering collaboration among participants. However, a teacher can also incorporate the voice agent into the classroom and use it with their supervision as a teaching assistant. The teacher can include educational audio stories and connect them to the in-class learning experience.

### 5.2.1 Written Scenario's

In order to delineate a conceptual idea about the interaction between users and the device, written scenarios have been created.

**Scenario 1: Joining play**

As the recess bell rings, Sam slowly walks out to the playground. Sam spots a group of classmates playing a game on a new device in the playground. The device lights up and makes sounds, capturing the children's attention.

Sam stands at a distance, watching the others play. Sam's eyes follow every movement, interested but hesitant to approach. The children, absorbed in their game, don't notice Sam standing alone. After a while, Sam notices children joining by simply tapping in. He sees that a lot of different children join in, even ones that normally don't play together. Sam feels a sense of relief seeing how easy it is to join. The device's voice agent has just started a new game and a loud "New players can join the game by tapping the sensor." echoes over the playground.

Encouraged by the simplicity of joining, Sam walks over to the stand and taps against the sensor on the device. The device lights up and a friendly voice says, "Welcome, Sam! Great you're joining us."

The group of children hear the announcement and look over. One of the children, Alex, smiles and waves at Sam. "Hey, Sam! We're in a team! Sam, feeling more confident, walks over to the group and starts participating in the game. The voice-based games require teamwork and communication, but thanks to the wristbands and voice agent, Sam can join in without the initial anxiety of speaking up.

As the game progresses, Sam integrates smoothly into the group, interacting and cooperating with the other children. The device facilitates inclusive play by encouraging group tasks and celebrating each player's contributions, making everyone feel valued. By the end of recess, Sam is actively participating and smiling, having made new friends and feeling a sense of belonging.

**Scenario 2: Unengaged in Play**

Jake has joined play on the voice agent with a group of seven other children. They have already played an adventure story and have placed the second hat to start a new game. Jake is losing his concentration as the introduction text takes children on a journey to castles and knights. Jake sees his crush playing on the other side of the playground and stares at her, not actively listening to the voice agent anymore.

The voice agent announces the start of a game called Speed Tag. Team Pink has to tag as many children as possible while the voice agent plays a song. The children in Team Pink start running, they see Jake standing still and call out to him. "Hey, Jake! We need you for Speed Tag! Tag as many others quickly". Jake is back in the game and feels motivated to participate and help his team out. They tag as many other children as possible, running as quickly as they can. In the end, the voice agent asks if they tagged a lot of people and all the children of Team Pink proudly answer a loud yes. The voice agent says they did well and Jake feels like he contributed well, making him feel included.

By the end of recess, Jake is actively participating and smiling, having re-engaged after getting distracted and feeling a sense of achievement and belonging.

## 5.3 Specification of Design Components

### 5.3.1 Embodiment of the Voice Agent

**Tap In System**

The ideation phase identified a tap-in and out system as a desirable solution, where children select a figure, character, or dress-up piece to represent themselves. This approach allows children to join the game autonomously, eliminating the need to ask for permission. By choosing an item, children feel a sense of ownership and involvement. The voice agent enhances this experience by greeting each child and providing clear instructions, ensuring they understand what to do. Furthermore, the voice agent can personally address the children through the roles represented by their chosen items, fostering a more engaging and personalised interaction. Figure 5.1 visualises what such a system with characters could look like.
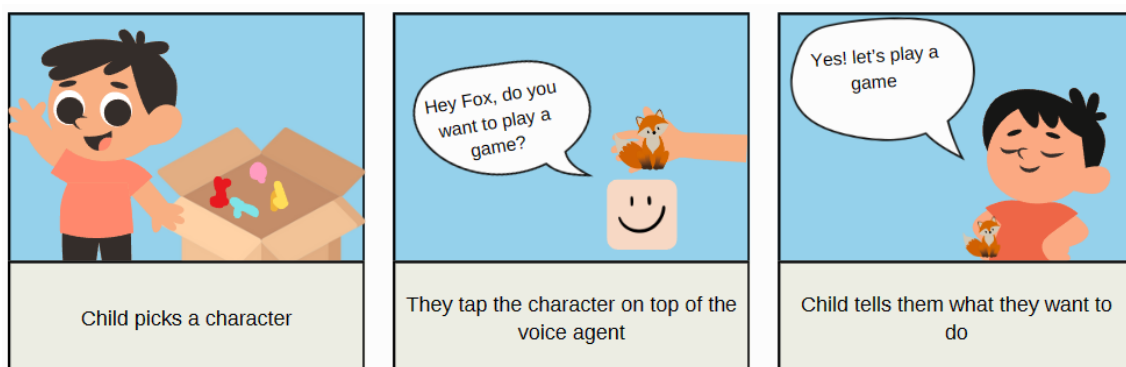


FIGURE 5.1: Visualisation of a tap-in system with animal characters

There are different items that could be used to tap in. The children could have a figure, like a pawn or Lego character, to tap and hold during the game or leave at the base station. The disadvantage of this is that items could be lost as children run off with them or forget to tap out. Another idea is to make the tapping-in item wearable, like a hat, piece of clothing or wristband, so that children do not forget. Different options are depicted in figure 5.2
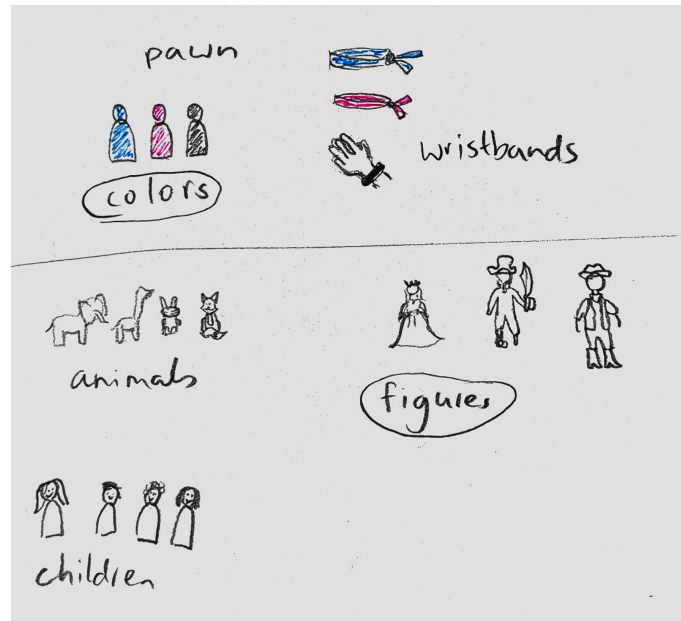


FIGURE 5.2: Tapping in with different items

An alternative implementation of the tap-in system involves keeping the items used to tap in on a station or base of the voice agent. This method ensures a constant visual representation of who is participating in the game and reduces the likelihood of characters getting lost. Such a system calls for an embodiment of the voice agent that accommodates the placement of characters. A sketch of what this could look like is shown on the right side in Figure 5.3. The sketch illustrates an example with a mountain featuring designated spots for character placement and room for a building representing a game on top.

In the end, the wristbands were chosen as the preferred solution, as they prove to be sturdy, can not get lost and have a clear function. The wristbands can have unique characters shown on them that provide the players with a nickname. By assigning different colours to the wristbands and providing multiple wristbands in the same colour, the system also offers a convenient way to form teams.

**Picking Games**

Given that back-and-forth communication with kids can be chaotic, interacting through voice is not preferred. If the voice agent were to ask what game the children would like to play, they would need to discuss and reach a clear decision, which the voice agent would then have to accurately interpret. Instead, alternative methods for selecting games, such as buttons or physical items representing different games, could
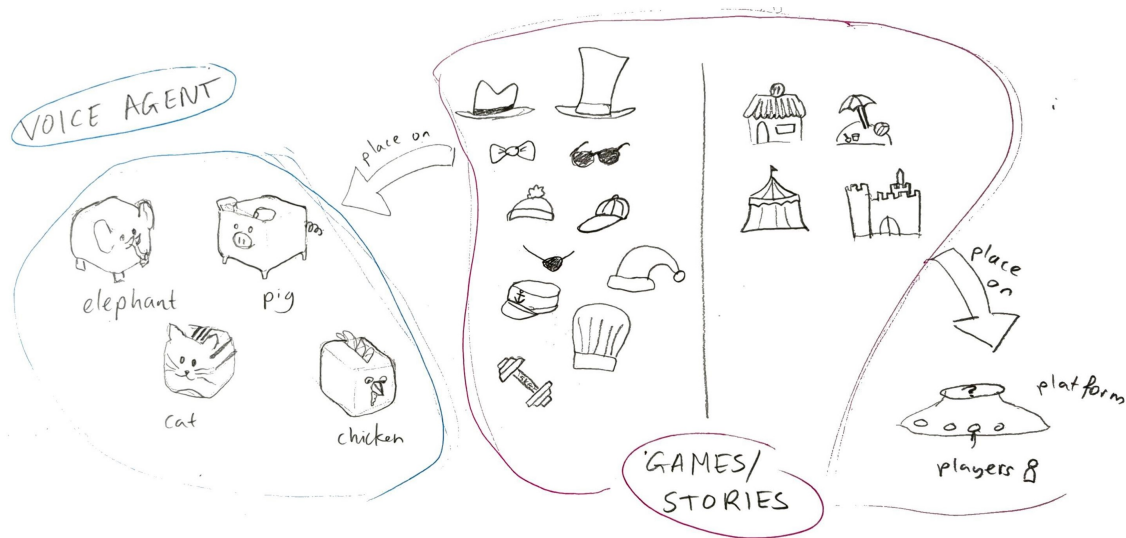
FIGURE 5.3: Two options for the voice agent and how to pick stories/games

be more effective. Some sketches illustrating these options are shown in Figure 5.3. The left side of the image demonstrates how games can be selected using for example hats placed on the animal voice agent, while the right side visualizes the idea of representing games with buildings or locations that can be placed on a base station.

Ultimately, the decision was made to use hats to represent stories and games. This method proved to be easier to link to games logically compared to using buildings. However, this decision introduced new challenges, such as ensuring the hats do not get lost. One solution is to assign a designated storage spot, like a dress-up chest. This chest could even be designed to sense if all the prompts are back in place or if something is still missing.

**Physical Representation of the Voice Agent**

From the requirements also came the idea that speaking devices that talk to children should have at least a minimal physical representation. Mimicking people can be scary (Yip et al., 2019), so picking an animal is a safe bet. A dog was chosen as a good fit for the embodiment in the end. Dogs are universally recognizable and often beloved by children of all ages. They are familiar figures in many children's lives, whether as pets, characters in books, or in media, making them an immediate and comforting presence. Furthermore, dogs are often associated with loyalty, companionship, and protection, qualities that align well with the supportive role of a voice agent. These attributes, combined with their playful and approachable nature, make dogs an ideal character for the voice agent.

## 5.4 Conclusion

The specification chapter has helped decide on the specifics of what the voice agent will look like and what kind of games it will accommodate. Figure 5.4 shows a sketch of the final design idea. This consists of four parts; wristbands for children to wear

and tap into the game, the voice agent that will accommodate the voice-based games, hats for the voice agent to select games and a chest to make sure everything gets placed back after play. The wristbands assign children a nickname and a team by linking animals to colours, this is more elaborately described in the next chapter, describing the realisation of these four sub-systems.



FIGURE 5.4: Sketch of the final design specification

# Chapter 6

# Realisation of Voice Agent

This chapter will detail the creation of the envisioned product. As identified in Chapter 5.4, the product consists of four sub-systems: the tap-in system and the picking games system, which are integral to the physical embodiment of the voice agent. This agent plays audio fragments based on inputs from these two systems. Table 6.1 presents a comprehensive analysis of these sub-systems and their required components. Each sub-system and its elements will be discussed in individual subsections within this chapter, aligning with the divisions outlined in the table. The technological realisation of these elements will be the primary focus of this chapter. For a discussion on the development of the games and the underlying play theories, please refer to Chapter 7.

TABLE 6.1: Sub-Systems of the Desired Product

| Sub-system | Function | Physical Elements | Digital Elements |
|---|---|---|---|
| Voice Agent | Play audio games | Representation of Animal | Recognize wristbands and accessories |
| Game Selection System | Allow game selection | Hats and accessories | Unique recognition sensors |
| Tap-In System | Allow seamless joining | Colored wristbands | Unique recognition sensors |
| Storage System | Make sure stuff doesn't get lost | Storage chest | Recognition of elements contained |

## 6.1 Embodiment of the Voice Agent

A rounded wooden box, measuring 18 by 18 cm, serves as the base for the embodiment of the voice agent. The electronics and speakers are housed within this box. The internal components were glued in place to ensure stability during movement of the voice agent. The top wooden plate is designed to function as a lid, remaining unglued and capable of opening and closing. To achieve a soft texture and simulate the appearance of a dog's fur, two layers of felt were glued to the exterior of the box. Finally, the face, ears and collar were also created from cardboard and felt and affixed to the box.

## 6.2 Game Selection System

The game selection system allows children to decide on a game to play by placing a corresponding hat on top of the voice agent. Once a hat is placed on top of the voice agent the voice agent will play the recording connected to that game.

### 6.2.1 Creating the hats

The hats have been hand-crafted using felt and cardboard to make them soft, lightweight and easy to handle. It also promotes the crafting of new hats by the teacher or children. The realised hats and games they represent are shown in Figure 6.1 and the games they belong to are discussed in Section 7.4.

### 6.2.2 Electronics

The game selection is registered through RFID communication. An RFID tag is stuck on the bottom of every hat in the centre and a RFID reader is mounted in the centre of the voice agent's top on the inside. The realisation is based on a project from makezine.com where a Teddy Bear was created to play audio files based on objects held against it (*Charlie's RFID Teddy Bear*, 2012). This project was altered to work with two RFID readers; one for the game selection and one for the tap-in system. Below the components used are listed:

1. 12 RFID tags
2. 2 RFID Readers: RC 522
3. Arduino Uno
4. SD card for storing audio
5. Loud Speaker
6. Wave Shield Kit from Adafruit 94
7. Battery holder
8. 6 AA batteries
9. Wires for soldering elements

The steps from the teddy bear reference were followed to connect the Wave Shield, speaker, RFID readers and Arduino with an additional RFID reader. This means that two RFID readers are initialized using different Chip Select (SS) and Reset (RST) pins. The loop function ensures that there is a continuous check for new cards on both RFID readers, depending on what reader detects a chip, a different handle function is called. The RFID Reader for the wristbands is connected to SS pin: 10 and RST Pin: 9, while the RFID reader for the hats is connected to SS Pin: 7 and RST Pin: 8, as also defined in the code. The Arduino code is shown in Appendix B.

## 6.3 Tap-In System

The Tap-In System consists of coloured wristbands with animal drawings on them. Figure 6.2 shows how the wristbands refer to different animals and colours. This way

(A) The sports game hat



(B) The boat game hat



(C) The chef game hat



(D) The circus game hat

FIGURE 6.1: The different realised game hats

children will be uniquely identified through an animal and will be part of teams based on the color attributed to that animal.



FIGURE 6.2: Image of the realised wristbands

Similarly to the hats, the Arduino will play a short audio file to welcome the player once their wristband connects with the RFID reader. The wristbands have been made from paper for the prototype, ideally, a strong flexible material would be used with the option to adjust its size, for example with velcro.

## 6.4   Storage System

In order to keep track of the components and make sure nothing gets lost a storage chest will promote cleaning up after play, like shown in Figure 5.4. The storage chest gives room to the different hats and wristbands. The storage chest can sense if all the components are back inside or if anything is missing. The chest has a large button on the front with the text 'clean-up'. Once pressed it will mention the missing items and children can look for them to make sure they are returned. This will turn cleaning up into a game where children carefully have to listen and find the item that fits the description. Due to time constraints, the storage system will not be realised for this project.

## 6.5   Discussion and Conclusion

In summary, the prototype successfully demonstrates the core functionalities of the envisioned interactive children's toy. The Voice Agent, crafted from a rounded wooden box and covered in felt, serves as an engaging and durable base for the system. The game selection system, utilising handcrafted hats with RFID tags, allows children to easily choose different games. The tap-in system effectively welcomes players into the game environment with personalised audio greetings.

However, several aspects, such as the refinement of the wristbands' material and the inclusion of a database to track player participation and adjust the audio files

based on that, require further development. In its current state, there is no database that keeps track of players tapped in. This means the games do not specifically call for participating players, but there is a hard-coded set of players that is called in the audio files.

The Arduino code also needs improvements so that it only plays a new game once a game has ended and ignores new placements while a game is already playing. Additionally, the Storage System, which was not realised due to time constraints, remains an important component for future iterations. Overall, while the prototype lays a solid foundation, additional refinements are needed to fully realise the product's potential and ensure a seamless, user-friendly experience.

# Chapter 7

# Game Implementations

This chapter will cover the creation of game scripts based on the preliminary requirements (see Section 4.3), game design theories, and the intrinsic values of play described in Section 2.1.2. Literature on game mechanics will be reviewed to refine and further specify the previously established requirements. Subsequently, multiple games will be constructed using the game construction method based on intrinsic values. The remainder of this chapter presents the scripts that have been recorded to play on the voice agent.

## 7.1 Game Mechanics

In designing the game mechanics, Schell's book, The Art of Game Design: A Book of Lenses (Schell, 2014) provides a comprehensive framework for developing engaging and effective game mechanics through various lenses. Schell's framework is applied to ensure that the games designed are engaging for children. Here, several relevant lenses from Schell's framework are applied:

1. **Lens of Surprise**: This lens emphasizes the importance of unexpected elements in games to keep them exciting and engaging. Adding surprising elements can maintain children's interest, especially when the medium is primarily audio.

2. **Lens of Cooperation**: This lens is essential for promoting social play. Designing games that require teamwork helps foster collaboration and communication among children, which is crucial for their social development.

3. **Lens of Reward**: Positive reinforcement is crucial to keep children motivated and engaged. The game should frequently acknowledge and praise children's efforts to maintain their interest and encourage continued participation.

4. **Lens of Control**: Providing children with a sense of control over the game can enhance their engagement and enjoyment. This can be implemented by allowing children to make decisions in games and encouraging creativity.

5. **Lens of Curiosity**: Engaging children's natural curiosity can make games more appealing. This can be achieved through exploratory elements and open-ended questions or scenarios.

## 7.2 Intrinsic Values and Themes

To illustrate the variety of games that can be played on the voice agent the intrinsic values to play as discussed in chapter 2.1.2 will be utilised. The games have been created by combining different sets of intrinsic values to get a diverse set of games.

## 7.3 Requirements Refinement

In Section 4.3, preliminary requirements were composed. These have been revised below based on the game mechanics and intrinsic values research. Knowing now that there will be multiple games, not all games have to comply to all requirements. A separate set of requirements that at least one of the games has to comply with has been added below.

1. **Easy Joining to Promote Inclusiveness**: Games allow for seamless joining to reduce barriers for children who may experience obstacles such as anxiety or fear of not knowing the rules.

2. **Discovery of Topics**: Through offering a variety of topics, the games enable children to explore topics they find interesting or learn about new topics.

3. **Variety of Physical Activities**: Games incorporate a variety of physical activities into play to cater to different interests and abilities.

4. **Trigger Intrinsic Values**: Games should trigger a range of intrinsic values with at least one clear physical and one social value.

5. **Lens of Reward**: Games should incorporate positive reinforcements through motivational and positive speech, making play rewarding for the children.

At least one of the games should focus on:

1. **Open-ended gameplay**: Providing open-ended gameplay experiences that encourage creativity, exploration, and social interaction. Avoiding rigid structures or predefined outcomes to allow for diverse playstyles and outcomes.

2. **Lens of Suprise**: including an element of suprise to make the game unpredictable and exciting.

3. **Lens of Cooperation**: requiring children to work together in assigned teams to encourage social interaction

## 7.4 Realised Games

Table 7.1 shows an overview of the realised games and the main intrinsic value they aim to trigger. They have been composed by linking as many different intrinsic values from each category, this is shown in the figures before each game script. Besides they have been designed to let the voice agent take on different roles towards the children.

TABLE 7.1: table showing the realised games

| Hat | Main Intrinsic Value | VA's role |
|---|---|---|
| Sports Cap | Release Energy | Coach |
| Captain hat | Construct | Peer |
| Chef's hat | Have a Sense of Identity | Assistant |
| Circus hat | Feel Motor Skillful | Host |

The sports game (Section 7.5.2) does not individually call on players, while the other games do. The sports game explicitly calls for the children to move and be physically active in order to trigger the want to release energy. By adding sounds and music an element of fun is included.

The boat game (Section 7.5.3) provokes the intrinsic value to construct as players are encouraged to build a boat. This can be done by providing large building blocks smaller Lego stones or letting the children imagine building material themselves. Besides constructing a boat the children are urged to solve the problem of their broken boat with whatever they have at hand.

The chef game (Section 7.5.4) lets children pretend they're working in a restaurant. PlayPuppy is their assistant, it doesn't know where everything is and asks the children to help him search Additionally, it makes a funny mistake, causing a surprise element when the soup dramatically explodes. There are many calls to individuals in this game, every other sentence a player is mentioned. Children are asked to think about the senses of a dish, but could also experience this if the play would take place with actual ingredients or fake ingredients like sand and water for outside use. As main chefs, they can feel pride in their creations and in helping out PlayPuppy.

The circus game (Section 7.5.5) is designed to foster open-ended play, children are free to decide on a circus act with the prompts at hand and can do whatever they want. The voice agent should wait for specific characters to tap in to continue to the next phase of the game, it for example specifically asks one character to tap in after a performance so that it knows the audio can continue. The circus game focuses on social play as it is all about working together to make an act.

All audio files are between 3 and 4 minutes long, although the circus game will take longer since the children will prepare and perform acts in between.

## 7.5 The game scripts

In this section, the scripts that have been recorded to play on the voice agent are presented. The games have been recorded and edited using Adobe Audacity (Adobe, 2024) and free CC0 sound effects from freesound.org (*Freesound*, 2024) have been profited from. Since the testing will be done with Dutch children, the audio recordings are in Dutch but they have been translated into English here. The scripts show animals getting called on and the voice agent will pick random present animals by keeping track of a database of animals participating. By asking everyone to tap in again every once in a while, we make sure the database is up-to-date even when players walk away without tapping out.

The first sub-section shows the starting text once the voice agent is turned on. The voice agent will repeat the last text if it detects no hat after 1 minute. The different greetings will play whenever that character taps in for the first time, which could happen at any time during the game. When a character is asked to tap in again midplay a sound effect will play and when the player taps out "goodye *character name*" is played. The other sub-sections are named referring to the hat that is placed to initialise them.

### 7.5.1 Start of the game

Hello everyone! Who wants to play a game? Grab a wristband and hold it against my collar if you want to join. If you want to watch first you can join anytime by grabbing a wristband! You can also stop playing by tapping a second time, so if you feel like leaving tap again.

- Welcome pig, how nice that you are joining!

- Hi peacock, glad you are here!

- Hello Tiger, you are so fast, welcome!

- Hey sly fox, are you in the mood for some fun?

- Flamingo, great to have you here!

- Oh butterfly, you are fluttering beautifully again.

- There is the beautiful peacock!

- Croak frog, are you jumping with excitement?

- Hey there brave crocodile, glad you are here to join us!

Now it is time for a fun activity, what do you feel like doing? Place a hat on me to start a game.
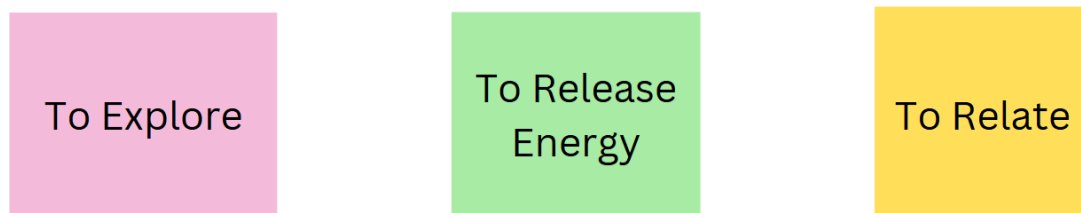
### 7.5.2 Sports Cap



FIGURE 7.1: Intrinsic Values of the Sports Game

"Hello handsome athletes, let's do a fun workout to get in shape and get stronger. We'll start with a warm-up:

**Warm-up**

"Okay, everyone, let's start with some jumping jacks. Ready? Go! Let's do 10 together. Count with me: one, two, three, four, five, six, seven, eight, nine, ten! Great job!

Now we're going to lift our knees up while running in place. Lift your knees high as if you were marching. Let's do 10 of these as well. Ready? One, two, three, four, five, six, seven, eight, nine, ten! Awesome!

Next, we're going to reach up to the sky and then touch our toes. Reach high! Now bend down and touch your toes. Let's do this five times. One, up and down. Two, up and down. Three, go up as high as you can and down. Four, up and down touch your toes. Five, up reach the sky and down. Great job, everyone!"

**Sound game**

"So we're quite warmed up, do you feel like playing a game? We're gonna be playing a game with sounds. When you hear a sound you have to do the corresponding movement. So you have to remember which movement goes with which sound.'

1. When you hear the bouncy ball, we're going to jump as high as possible like a bouncy ball *bouncy ball sounds*
2. When you hear the wind, you spin around with your arms as if you were a windmill *wind sounds*
3. When you hear barking, we're crawling around like happy puppies *dogs barking*

Let's practice first. Listen carefully! Ready? the bouncy ball, jump as high as you can! Good, keep jumping until it stops. Nice work! Do you hear that? That's the wind! Spin your arms around like a windmill and catch as much wind as possible. Then the last bark! Do you still know what that means? We're puppies that crawl around quickly on the floor. So: wind is spinning arms, bouncy ball is jumping and barking is crawling, are you ready to play? Here we go! *different sound effects play with motivational notes and help in between, a soft cheerful background music plays*"
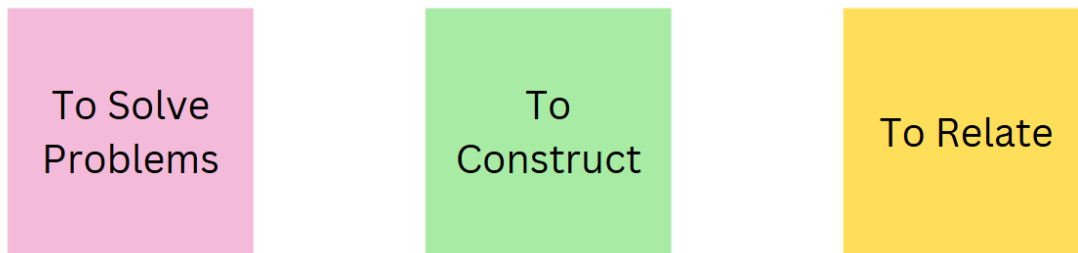
### 7.5.3 Captain hat



FIGURE 7.2: Intrinsic Values of the Sea Game

"Aye aye kids, we're going on a sea adventure! Are you ready? I can't hear you! Are you ready!!

Let's build a ship so we can go out to sea together. Let's build a boat together! Butterfly and fox can you look for materials to build the boat? Then tiger and pig can make paddles to row with. The other players can help build one or more ships. We have to be quick because we're in a hurry! I give you 20 seconds to build a boat *fast music plays*.

Nice, super well done, what a beautiful boat! Now it's time to go out on the water! Now we're going out to sail, but first we have to put the boat in the water. After you've put the boat in the water we can jump in. Is it in the water yet? When it is we can jump in at the same time on 3, 2, 1 Jump! *splash shounds*

*Water sounds* There we are, wonderfully on the water, but to move forward we have to row! Move the paddles quickly so that we can move forward. I'll set the rhythm so you can row at the same pace. *rhythmic drumming* Good job everyone, we're going so fast!

Oh no, look! The sea is getting rough! Big waves are coming our way. Quick, everyone duck for the water! *wave sounds* Now lean to the left, there's a huge wave coming! And now to the right! Great job, everyone, the sea is really stormy now. Hold on tight!

Oh no! Our boat has hit a big rock, and we've got a hole in it. Water is coming in! We need to fix the boat quickly before it sinks. Butterfly and fox, can you find some materials to plug the hole? Tiger and pig, can you use your paddles to scoop out the water? Everyone else, help out wherever you can! I give you 20 seconds to fix the boat! *fast music plays, storm and wave noises*

Wow, you did it! The boat is fixed and we are dry again. Well done! It's time to paddle back home and for me to say goodbye again, I had a lot of fun and look forward to play with you again soon!"

### 7.5.4 Chef's Hat

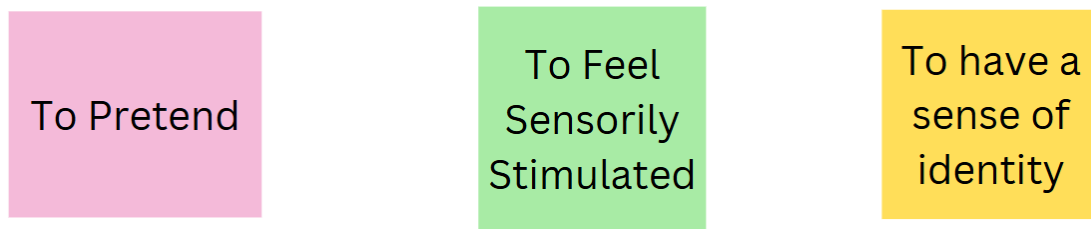| To Pretend | To Feel Sensorily Stimulated | To have a sense of identity |
|---|---|---|

FIGURE 7.3: Intrinsic Values of the Restaurant Game

"Hello chefs, I heard we're going to cook together! You are the boss today and I will be your assistant chef.

So, what shall we cook? Butterfly, what is your favorite food? Hmmm, good choice! Does the rest like it too? Crocodile, what do you think? Fantastic! Let's make it!

Okay chefs, first we need to gather all the ingredients. Only problem is, I have no clue where they are, can you help me? Can you quickly find some ingredients, I forgot what we need? *music plays and sounds of pans and pots clinging plays*

Very well done! Now we have everything we need. Let's start cooking. Soup is on the menu as a starter. We have to heat it up and stir it. Everyone, grab a big spoon and stir! Stir, stir, stir! Fantastic!

Now we have to knead the dough for the main course. Pretend you have a big ball of dough and knead it well. Knead, knead, knead! You're doing great!

Time to make pancakes! Grab a pan and a spatula. Flip the pancakes in the air and catch them again! Flip, flip, who can go the highest? Wow, you really are master chefs!

Oh no! I forgot to turn off the stove and it started a fire! *fire alarm sound* We have to run away quickly before the pan explodes and we are covered in soup! Run, run, run! Everyone go to a safe place! *explosion sound*

Phew! That was exciting! Fortunately, we are all safe and the fire has been extinguished. Let's clean up the soup because there are splatters of soup everywhere. We have to scrub and mop all the places well so that everything is tidy again! Rub it firmly until everything is gone!

Butterfly, can you remove that spot back there? Peacock, look under the table, there's something there too! Frog, can you clean the chair legs? Pig, would you mop up that big puddle over there? Flamingo, look next to the stove, there are still splashes there! Crocodile, will you help scrub the floor? Fox, can you clean the wall? Tiger, would you like to take off the cupboard doors?

Well done, you are doing so well! It looks spick and span again! You are amazing

cleaners! Time to set the table. Pig, can you put down the plates? Peacock, are you putting the cutlery in the right place? It looks beautiful!

Now we will enjoy the delicious food we have prepared together. Thanks for cooking and happy food, see you next time!"

### 7.5.5    Circus Hat

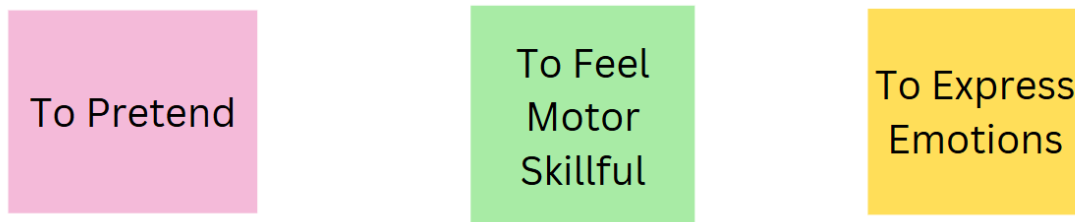| | | |
|---|---|---|
| To Pretend | To Feel Motor Skillful | To Express Emotions |

FIGURE 7.4: Intrinsic Values of the Circus Game

"Hello everyone, welcome to the best children's circus! My name is Puppy, and I'm your host today. Are you ready to see spectacular acts and participate yourself?

Today we are going to perform a fantastic circus act in four groups. Have a look at your wristbands; each colour wristband represents a group. We have the blue group; let's hear it, the pink group; do a jump, the orange group; can you do a spin and finally the green group; wave to me!

Your task is to invent and prepare a fun act in your group. This can be anything; do a dance, show how good you are at sports or athletics or prepare a trick! Use your imagination and work together to create something very special! At the end, we are all going to perform for the others so make sure you have a fun act to watch. It is now time to think of something fun, when you have something prepared, 1 person from the group can tap me to indicate that your team is ready. *wait until everyone is ready*. Then you can now start creating an act 3, 2, 1, Let's get started!

Okay, blue group, are you ready? What great act have you come up with? Butterfly can announce you by explaining what you are going to do and then you can start! When you are ready, peacock can tap on me again. * children do act, peacock taps the VA *

Wow, what an act! Let's give them a big round of applause! *applause sound effect*

Now it's team pink's turn, what do you have in store for us? Pig will announce the act in style and then you can start! When you are ready, flamingo can indicate that by tapping me. * children do act, flamingo taps VA*

Wow, pink group! That was really great! A big round of applause for you! *applause sounds*

Team orange, it's your turn now! Tiger can announce the act in style and then you can show what you have come up with. Fox will tap me at the end when you are ready. * children do act, Fox taps VA*

Wow team orange, what a cool act! That definitely deserves a round of applause! *applause sound effect*

Then finally it's team green's turn! Show us what you came up with! Crocodile makes the announcement and frog can tap me again when you're done. *children do act, frog taps VA*

Awesome team green, that looked really great! Give them a big round of applause! *applause sound effect*

That's it for now! I really enjoyed your acts, you could actually start a circus together. You worked together very well and that's how great things come about! Thanks for participating and see you next time!"

## 7.6  Reflection

The design and implementation of the games detailed in this chapter demonstrate a thoughtful integration of game mechanics and intrinsic values of play. Each game is designed to cater to different aspects of children's development, from physical activity to social interaction and exploration. By leveraging the frameworks and lenses provided by Jesse Schell, the games ensure a rich and engaging experience for children.

Moreover, the flexibility of the system allows for further customisation and creativity. Teachers and children can create their own hats and link them to new audio files, expanding the variety of games and themes. This adaptability ensures the system remains relevant and engaging over time, as well as keeping it customised to fit the teacher's learning goals.

In conclusion, the creation of game scripts has successfully incorporated theoretical insights into practical applications. The games designed meet the refined requirements and the approach taken in this chapter provides a framework for future development and expansion of interactive games using voice agents.

# Chapter 8

# Evaluation Method

The following two chapters will focus on answering the last sub-research question: 'Are the designed voice-based games effective in promoting physically active social play?'. This will start with determining whether the realised product aligns with the intended design. Besides, the evaluation will consider whether new insights into the design space have been gained. This chapter will explain the evaluation method, while the next chapter outlines the results from the study.

## 8.1 Study Design

This study involved groups of children playing all four games designed for the voice agent; PlayPuppy. The aim was to observe their interactions and gather feedback to assess the effectiveness and appeal of the games. A total of 28 children (all between 4 and 6 years old) participated in 5 groups (two groups of 6 and two groups of 8). Children were assigned in groups by their teacher, making sure there was a mix of younger and older children. The play took place in a separate room with a small stage to delimit the play area.

## 8.2 Recruitment

The children's parents were approached by their teacher, who distributed information packages containing a short introduction letter, a detailed information brochure, and a consent form to their parents (see Appendix D). Children were eligible to participate in the research if their parents returned the signed consent within one week.

## 8.3 Apparatus

As detailed in Section 3.3.1, the Wizard of Oz technique was employed for the user test. Specifically, the researcher manually played audio files on a Bluetooth speaker instead of triggering them through the RFID reader. The game also did not keep track of what characters were tapped in or out while the audio files did mention specific players. To accommodate groups of 8 or 6 children, two versions of the boat, cooking and circus game have been recorded so that only characters playing would be

(A) Close-up



(B) Overview with blocks for the boat game

FIGURE 8.1: The evaluation set up

called for. The setup as depicted in Figures 8.1a and 8.1b shows the voice agent with a Bluetooth speaker inside and the four crafted hats in a box next to it.

## 8.4 Testing Procedure

1. **Handing out wristbands**: The researcher randomly assigned wristbands to players and tied them around their wrists.

2. **Briefing**: The researcher provided a short briefing: "You will now have the chance to play with PlayPuppy. PlayPuppy will talk to you and play games. I will turn it on now and then PlayPuppy will explain the rest."

3. **Initiation**: The researcher started PlayPuppy. The introductory audio fragment provided further instructions, telling them to tap-in and pick a hat.

4. **Tapping-in**: Children used their wristbands to one-by-one tap into the game. The researcher plays the correct greeting sound file for every wristband.

5. **Picking a game**: Children place a hat on top of the voice agent and the researcher plays the associated audio file.

6. **Playing the game**: Children play the game or tap out if they are not interested.

7. **Short interview**: After every game, the researcher starts a recording and asks questions about that specific game. Consequently, the children are told they can continue playing and steps 4 to 6 are repeated until every game has been played.

In addition to free play, specific scenarios were orchestrated to observe particular interactions. This meant that if the tap-in system was not spontaneously used to join play at a later moment or leave before the end, a situation was created where children were told they could not tap in from the start or should leave before the end.
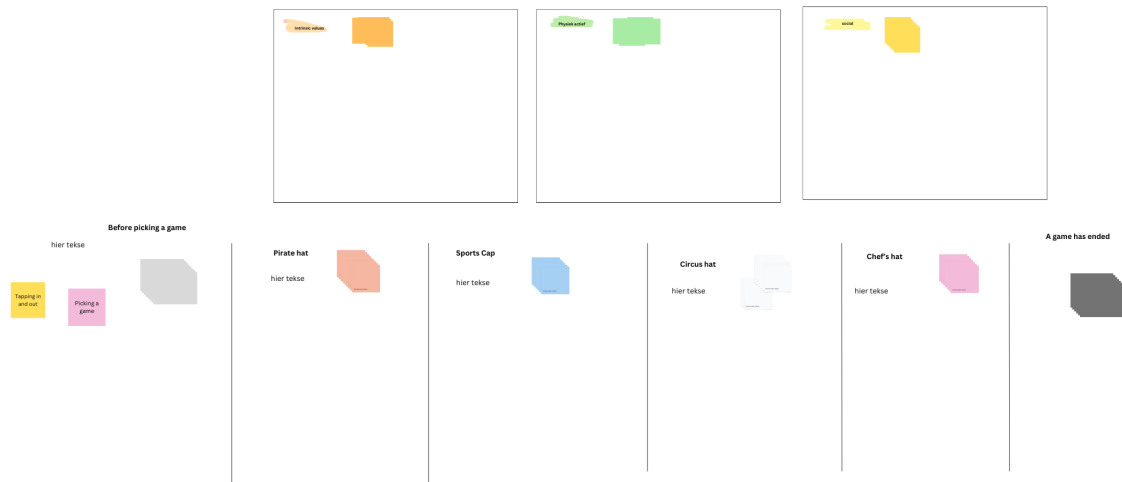
FIGURE 8.2: The observation canvas used to structure notes during the playtest session

## 8.5 Measures

An observation canvas was created beforehand to guide the note-taking process. Themes for data collection were identified and specific areas and colours were designated for notes related to these themes. The observation canvas is depicted in Figure 8.2 and shown in large in Appendix E.

After each game, the researcher asked what the children's first impression was of this game, after which they could continue their play and pick a new hat. After the last game, a longer semi-structured interview took place. This was recorded so that the researcher could focus on asking questions, rather than making notes. The recordings were transcribed after the interview and deleted within two days. This semi-structured interview focused on gathering data from all themes of the observation canvas. The researcher would show a hat and ask the following questions regarding that hat:

1. What do you remember about this game?

2. What picture fits best with the voice agent in this game? Why?

3. What picture does not fit with the voice agent in this game? Why?

Other questions were asked for specific games, like 'how tiring was the game?' (sports cap) or 'what did you think of the task you were given?' (circus game) were asked to gather information on the intrinsic values. After quickly touching upon all the games, children were asked what game was their favourite and least favourite and why.

## 8.6 Procedure for Analysis

All observations were cleaned and interviews were transcribed. A thematic analysis was performed with a deductive approach focusing on the following themes:

1. Engagement and Motivation

2. Physical Activity Levels

3. Social Interaction

4. Intrinsic Values

5. New Insight Into Design Space

This meant the observational notes were categorised based on these themes. Next, there was a latent approach to analysing the data, meaning assumptions were made about the subtext of what the children were saying. The results of the analysis are presented in the next chapter.

# Chapter 9

# Results

This chapter presents the results of the user test. The main goal is to determine whether the games effectively promote physically active social play. This starts with assessing the alignment of the product to its intended design and the functionality of its sub-systems. Next, we address the sub-research questions by examining observed engagement, levels of physical activity, and social interaction. We then analyse each game to see if the intrinsic values they aimed to provoke were observed. Finally, new insights into the design space are interpreted, and the chapter concludes with a summary of the main results.

## 9.1 Alignment with Intended Design

### 9.1.1 Voice Agent Embodiment

The children received the embodiment of a dog well. At the start of the day, children were given a colouring page to introduce the study (see Appendix D). This led to some children discussing their own dogs or dogs they knew, giving the voice agent a familiar persona. Notably, one girl even gave PlayPuppy a kiss at the end of the play session, indicating a strong positive connection with the voice agent.

### 9.1.2 Tap-In System

Children enjoyed tapping in and were keen to hear the welcome phrase for their animal, often laughing together. However, nicknames were mentioned too quickly during fast-paced activities like the cleaning in the chef's game, which meant that the children could not keep up. Longer pauses, such as when Butterfly was asked about their favourite food, helped children recognize their nicknames. In one group, children called each other by their nicknames, e.g., "Pig, Pig, we should make a stage." Children had no difficulty acknowledging that besides being an animal they also belonged to a team represented by the color of the wristband. Teams were easily recognised by colour at a glance.

### 9.1.3 Game Selection Mechanism

Children were intrigued by the selection of hats, immediately drawn to them and discussing which one to place. Preferences varied, with every hat being mentioned as a favourite at some point

Picking a hat caused more commotion than anticipated. One group argued over who could place the next hat, while another group discussed which hat to place next even before the end of a game. However, these disputes were resolved without the teacher's interference. In other groups, older children took the lead, collectively deciding which hat to place. In one instance, a younger child wanted to place a hat that had already been used, but an older child intervened, advising to wait until the game finished and then guiding the placement of a new hat.

Children were also curious to test what would happen if multiple hats were placed or if a hat was switched halfway through a game. The voice agent simply continued to play the current game, which quickly stopped them from trying. In the first group, when the voice agent wasn't loud enough, children started playing with the hats and trying to wear them.

## 9.2 Effectiveness in Promoting Physically Active Social Play

### 9.2.1 Engagement and Motivation

Engagement varied across groups. In the first group, low speaker volume hindered engagement, as children struggled to hear over their own movements. Subsequent groups had a louder speaker, improving engagement.

The last group was highly energetic and struggled to focus, getting distracted by the play area and toys. Even though they were mostly engrossed in other activities, the sound effects in the chef's game, like the boiling soup and fire alarm, momentarily re-engaged them, prompting them to gather around the voice agent and react to the game's events by running and hiding.

The middle three groups were well-engaged in the play and motivated to listen and follow instructions. In the second group, a boy who was bored tapped out after sitting out the first two games, leading to increased engagement among the remaining children.

### 9.2.2 Physical Activity Levels

Observations indicated active engagement in physical components of the games. During the Sports game, children enthusiastically performed activities like jumping and waving their arms. Instructions for some activities, like jumping jacks, were sometimes unclear or too quick, leading to confusion. The chef's game effectively promoted physical activity with simple instructions followed eagerly. Open-ended prompts, like those in the Circus game, caused some confusion, as explained in Section 9.3.4.

### 9.2.3 Social Interaction and Cooperation

PlayPuppy effectively facilitated social interactions. The game selection process encouraged cooperation and discussion. Occasional disputes were resolved without adult intervention, indicating conflict resolution skills. Activities requiring teamwork, like the Circus game, saw children collaborating and applauding each other, enhancing their social play experiences.

## 9.3 Intrinsic Values and Game Design

### 9.3.1 Game 1: The Sports Game

The sports game aimed to let children release their energy and explore different movements. Most children did not know what jumping jacks were so they just started jumping. They would always count along with the voice agent. The sound game was well received by almost all groups. They especially seemed to enjoy playing dogs and started barking out loud. This led to sometimes missing instructions, but overall there was no issue. The jumping and waving were done very fanatically and the children got noticeably tired. One girl stopped waving her arms at one point and started standing still and blowing air fanatically to mimic the wind sounds.

### 9.3.2 Game 2: The Boat Game

Children appeared to enjoyed constructing the boat and they worked well together without disputes. They enjoyed the sound effects and some children acted out waves. In one group, children continued constructing in the next game as they built a circus out of Lego in the next game instead of performing acts. Some instructions, like 'duck to the left,' were challenging as children struggled with the difference between left and right.

### 9.3.3 Game 3: The Chef's Game

The chef's game aimed to stimulate sensory experiences and a sense of identity. Children enjoyed guiding the chef, finding ingredients, and laughing at the chef's silliness. Since the children decided themselves what they would make they were happy with the results and recalled what had happened well. Sensory stimulation was less apparent but could be enhanced with more tactile play environments, such as a sandbox for kneading dough.

### 9.3.4 Game 4: The Circus Game

The circus game focused on cooperation and pretend play. Children generally enjoyed creating and performing acts, though the level of pretend play varied. Some teams quickly devised acts, while others needed more guidance. During one session three teams quickly came up with acts, while one team was left with no clue on what to make. The fact that the other groups were waiting on them put extra pressure on them and in the end they did not perform anything.

As explained in Section 9.3.2, there was a session where children built a Lego circus instead of performing physical acts as they had just played the construction game. This shows how the open-endedness allows for flexibility in play styles.

Positive feedback from peers, like applause, motivated children and enhanced their experience of feeling motor skillful. There were no disputes about the teams and children seemed to have no trouble working together with children that they normally don't play with.

## 9.4   Further Insight Into the Design Space

The environment likely significantly influences the play. Larger spaces allow for more movement but can also cause increased distraction. For highly energetic groups, an unfamiliar play area with other toys was particularly distracting, suggesting that familiar environments might aid focus. Ensuring loud enough speakers is crucial for maintaining engagement, as evidenced by the first group's struggles with a low-volume voice agent. Children carried intrinsic values from one game to the next, showing lasting impacts of the play activities.

## 9.5   Summary of Results

The user test demonstrated that the games effectively promoted physically active social play when the design aligned with the intended objectives. Engagement varied with speaker volume and the children's energy levels. Physical activities were well-received, though some instructions needed clarification. Social interactions were positively influenced by the games, fostering cooperation and conflict resolution. Each game provoked the intrinsic values intended, with observed behaviours reflecting these goals.

# Chapter 10

# Discussion

This chapter presents a brief recap of the key results, their implications, and their significance. Additionally, the limitations of the research are discussed, and recommendations for future research are proposed.

## 10.1   Major Findings and Their Meaning

The results reported in Chapter 9 indicate that the designed voice-based games and the voice agent effectively facilitated physically active and social play in the user tests. Although direct comparisons are challenging, the children were actively engaged in physically active social play during their sessions. The voice agent accommodates for social discussion to decide which hat to play and the children enjoyed getting called by their nicknames, although they did not always notice in time. The games also successfully provoked the specific intrinsic values, as the observations saw children construct, getting tired, feeling skilful in their acts and pretending to be cooks.

These findings demonstrate that voice-based games can effectively engage children in screen-free play. Incorporating music and sound effects successfully encouraged physical movement. The children appeared to respect the voice agent, following its commands, enjoying simple tasks and showing contentment when receiving praise. Additionally, the technological sub-systems allowed for social play as children decided on games together and could join play seamlessly. This suggests that voice-based interactions can be a valuable tool for promoting active and socially engaging play among children, providing an alternative to screen-based activities and lowering barriers to play through technology.

## 10.2   Limitations

Although the study was designed to be as sturdy as possible, there are limitations to be noted.

Firstly, design choices have been made based on assumptions. This meant, for example, that the decision to focus on a tapping-in system with nicknames was picked over focusing on giving feedback on physical activity. Also, in the realisation chapter

preference was given to wristbands over physical characters based on the assumption that children could lose anything they would have to hold.

Secondly, the testing procedure introduced some uncertainties and limitations. Due to the way the testing procedure was set up, there were fewer social barriers in the testing environment. Barriers like not daring to ask to join were diminished slightly due to the set-up of the research where participating insinuated that you could join the play.

Also, the picture task did not lead to the desired data. Children did not know how to explain their choices and often fell silent after the question of why they picked a certain image to represent the voice agent.

Next, the thematic analysis relied on observational notes, which are inherently subjective. Capturing and interpreting children's experiences during play is challenging to do objectively, especially if you expect certain behaviour. This could affect the reliability of the findings.

Lastly, it is difficult to ascertain the extent to which voice-based games promote physically active social play compared to other methods, as there were no control groups or comparative analyses with traditional play settings. We can note that the play was physically active and social, but we cannot compare it to, for example, a random play session during free play time on the playground.

## 10.3   Recommendations for Further Research

As established in the limitations, the testing of the voice agent and games was difficult to do unbiased and it is difficult to draw conclusions on the effectiveness of the voice agent when there is no situation to compare it with. Future research could therefore look into the physical and social effects of voice-based games in comparison to a traditional play setting. Doing the studies over a longer period of time could also give more reliable data and show whether the play with the voice agent remains interesting over time, or whether children lose their interest once the toy isn't new anymore. Additionally, testing the device in real playground settings could also evaluate the effectiveness in diminishing social barriers better, as the staged set-up already lowered the barriers to joining.

Since some design choices have been made on assumptions, further research could also look into the other options to determine whether they are better or worse. This means research could look into using other objects for personalisation than wristbands or different physical prompts to represent stories.

Also, specifically including motion detection sensors to include feedback on physical activity could be beneficial. The current design had no sensors and the voice agent just gave praise without knowing what was happening, which appeared unnatural when children were not actively participating. Motion detection sensors can also allow for competitive games as the voice agent has a way to decide on a winner.

## 10.4 Conclusion of Discussion

In summary, the design and implementation of voice-based games successfully integrated game mechanics and intrinsic values of play, resulting in engaging and effective experiences for children. The study highlights the potential of voice-based interactions to promote screen-free, physically active, and socially engaging play. However, the limitations identified suggest that further research is needed to refine the design, incorporate additional features, and conduct longitudinal comparative studies to validate the findings. By addressing these areas, future research can enhance the understanding and application of voice-based games in promoting healthy and active play for children.

# Chapter 11

# Conclusions

This thesis aimed to identify ways to lessen social barriers to play and make physically active social play engaging using a voice agent, answering the research question:

> **RQ:** How can voice-based games effectively encourage children to participate in physically active social play?

Based on a qualitative analysis of user test evaluations and transcriptions, it can be concluded that the following factors were found to be effective in accommodating the desired play using a voice agent and its voice-based games.

- Letting children tap in as a character through wristbands

- Allowing for social discussion to pick a game by placing a hat

- Giving compliments and using motivational language

- Re-engaging children through elements of surprise (for example sound effects)

- Assigning random teams and working together on tasks

The results indicate that the designed voice agent and voice-based games were effective in stimulating physically active social play using above-mentioned elements.

## 11.1   Summary and Reflection

The research focused on two main areas: designing the voice agent and developing the game content. The voice agent was designed to mitigate social barriers and promote active play, incorporating RFID readers and RFID-chipped hats and wristbands to facilitate seamless play entry and game selection.

Game development involved exploring various play themes, specific movements, and game concepts, evaluated against intrinsic play values. Game mechanics from Schell's "The Art of Game Design" were used to enhance engagement and social interaction.

A user study with 24 kindergarten children, divided into five groups, evaluated the effectiveness of the voice agent and games. The study focused on engagement, physical activity, social interaction, intrinsic values, and new insights into the design space.

## 11.2   Contribution to the field

This thesis introduces a novel system for identifying and categorising play by integrating intrinsic play values. Unlike many existing categorisation systems, which often overlap but fail to agree on a basic set of play types, this new system unifies them by examining the underlying reasons why a child engages in a particular type of play. This approach aligns with the established definition of play, which states that play is both purposeless and done for its own sake, driven by the child's intrinsic motivation rather than external factors.

Additionally, it introduces a voice agent and voice-based games that promote physical activity and reduce social barriers, using innovative tools such as wristbands and hats for game selection and participation. This combination represents a significant advancement in creating engaging, physically active social play experiences for children.

## 11.3   Final Remarks

Ultimately, each child will react to a voice agent in their own way and should engage in play only if they choose to. While efforts can be made to make play engaging and personal, triggering intrinsic values and lowering barriers, play remains a voluntary activity. Therefore, it is up to the child to decide whether to participate in physically active social play.

# Appendix A

# Generative AI Disclosure

During the preparation of this work the author(s) used ChatGPT and Grammarly in order to help with the formality of the writing and improve the sentence structure. After using this tool/service, the author reviewed and edited the content as needed and takes full responsibility for the content of the work.

# Appendix B

# Arduino Code

---

```
#include <FatReader.h>
#include <SdReader.h>
#include "WaveHC.h"
#include "WaveUtil.h"
#include <SPI.h>
#include <MFRC522.h>

// Pin definitions for RFID readers
#define RST_PIN_1 9
#define SS_PIN_1 10
#define RST_PIN_2 8
#define SS_PIN_2 7

MFRC522 rfid1(SS_PIN_1, RST_PIN_1); // Instance for wristbands
MFRC522 rfid2(SS_PIN_2, RST_PIN_2); // Instance for hats

SdReader memcard;
FatVolume vol;
FatReader root;
FatReader file;
WaveHC wave;

#define NUM_ANIMAL_TAGS 8
#define NUM_GAME_TAGS 4

// Animal greeting tags and sound files
char animalTags[NUM_ANIMAL_TAGS][11] = {"04 3D 0A 63 5F 61 80", "04 56 97
    63 5F 61 80", "04 FA 67 63 5F 61 80", "04 C1 D1 35 4F 61 81", "04 5A
    3A 33 4F 61 80", " 04 87 F2 52 6F 61 80", "04 9D 06 30 4F 61 80", "04
    DB F4 32 4F 61 80"};
char animalSounds[NUM_ANIMAL_TAGS][9] = {"Varken.WAV", "Flamingo.WAV",
    "Vos.WAV", "Tijger.WAV", "Vlinder.WAV", "Pauw.WAV", "Kikker.WAV",
    "Krokodil.WAV"};
```

```
// Game tags and sound files
char gameTags[NUM_GAME_TAGS][11] = {"04 3E DD 36 4F 61 80", "04 92 94 50
    6F 61 80", "04 CE 72 50 6F 61 80", "04 80 97 30 4F 61 80"};
char gameSounds[NUM_GAME_TAGS][9] = {"Sports.WAV", "Boat.WAV", "Chef.WAV",
    "Circus.WAV"};

char filename[13];

void setup() {
  Serial.begin(9600);
  SPI.begin();
  rfid1.PCD_Init();
  rfid2.PCD_Init();

  pinMode(2, OUTPUT);
  pinMode(3, OUTPUT);
  pinMode(4, OUTPUT);
  pinMode(5, OUTPUT);

  if (!memcard.init()) {
    putstring_nl("Card init. failed!");
    cardErrorCheck();
    return;
  }

  memcard.partialBlockRead(true);

  uint8_t partition;
  for (partition = 0; partition < 5; partition++) {
    if (vol.init(memcard, partition))
      break;
  }
  if (partition == 5) {
    putstring_nl("No valid FAT partition");
    cardErrorCheck();
    while(1);
  }

  if (!root.openRoot(vol)) {
    putstring_nl("Can't open root directory");
    while(1);
  }

  putstring_nl("Ready to go");
}

void cardErrorCheck(void) {
  if(!memcard.errorCode()) return;
  putstring("\n\rSD I/O error:");
```

```cpp
      Serial.print(memcard.errorCode());
      putstring(", ");
      Serial.print(memcard.errorData());
      while(1);
    }

void loop() {
  if (rfid1.PICC_IsNewCardPresent() && rfid1.PICC_ReadCardSerial()) {
    String tag1 = readRFID(rfid1);
    handleWristband(tag1);
    rfid1.PICC_HaltA();
  }

  if (rfid2.PICC_IsNewCardPresent() && rfid2.PICC_ReadCardSerial()) {
    String tag2 = readRFID(rfid2);
    handleHat(tag2);
    rfid2.PICC_HaltA();
  }
}

String readRFID(MFRC522 &rfid) {
  String content = "";
  for (byte i = 0; i < rfid.uid.size; i++) {
    content.concat(String(rfid.uid.uidByte[i] < 0x10 ? " 0" : " "));
    content.concat(String(rfid.uid.uidByte[i], HEX));
  }
  content.toUpperCase();
  return content.substring(1);
}

void handleWristband(String tag) {
  Serial.print("Wristband detected: ");
  Serial.println(tag);
  for (int i = 0; i < NUM_ANIMAL_TAGS; i++) {
    if (tag.equals(animalTags[i])) {
      playfile(animalSounds[i]);
      break;
    }
  }
}

void handleHat(String tag) {
  Serial.print("Hat detected: ");
  Serial.println(tag);
  for (int i = 0; i < NUM_GAME_TAGS; i++) {
    if (tag.equals(gameTags[i])) {
      playfile(gameSounds[i]);
      break;
    }
```

```
  }
}

void playfile(char *name) {
  if (!file.open(root, name)) {
    putstring_nl("Couldn't open file");
    return;
  }
  if (!wave.create(file)) {
    putstring_nl("Not a valid WAV");
    return;
  }
  wave.play();
}

void silence() {
  if (wave.isplaying) {
    wave.stop();
  }
}
```

# Appendix C

# 100 ideas

FIGURE C.1: Brainstorm on themes for children's play



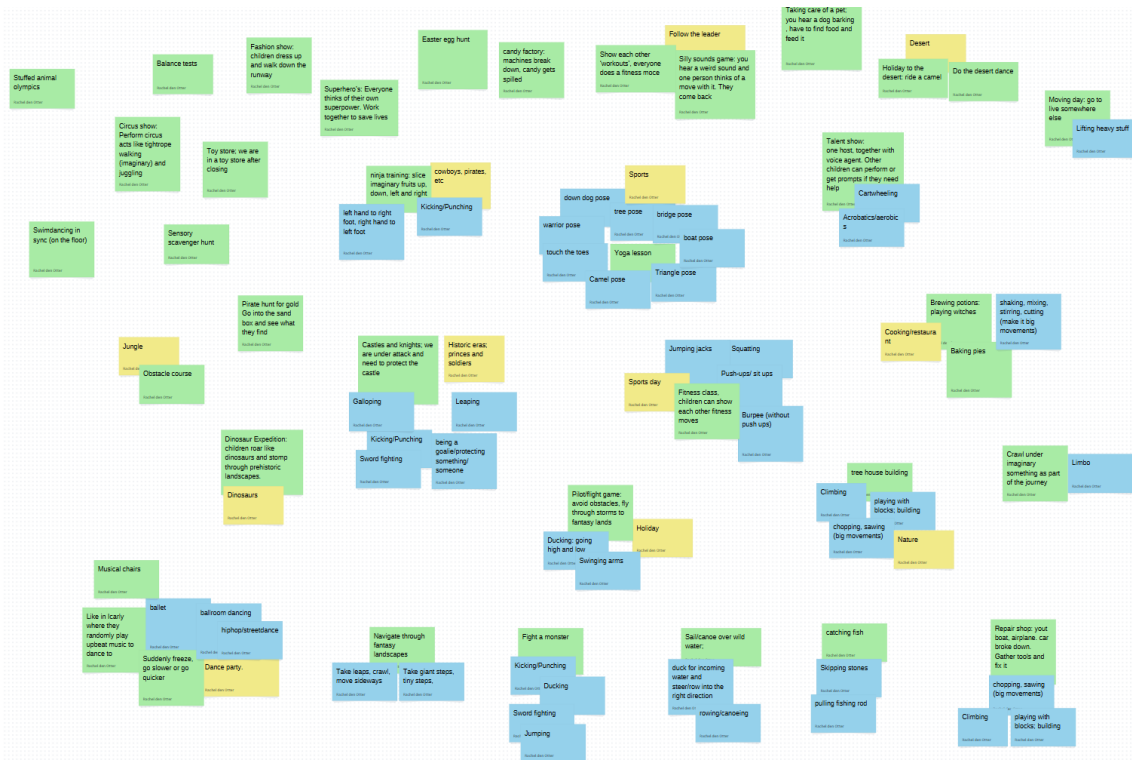FIGURE C.2: Brainstorm on movements in physical play

FIGURE C.3: Combining themes, movements and game concepts

# Appendix D

# User Test Recruitment Package

The package consisted of three items and was given to the parents a week before the testing took place. The introduction was given on top, with the other documents to read for the people interested in participating.

## D.1   Introduction

Figure D.1 shows a short introductory text printed on A4 to let the parents know about the research. It refers the reader to the information brochure for more information and notes that they do not have to do anything if they don't want their child to be part of the research.

Beste ouders/verzorgers,

Voor mijn afstudeerproject aan de Universiteit Twente heb ik een 'play buddy' ontworpen die interactieve audioverhalen verteld om fysiek actief sociaal spel te stimuleren bij jonge kinderen. Ik zou graag het product testen bij de doelgroep om te zien hoe kinderen ermee omgaan. Dit betekent dat ik langskom op school om groepjes kinderen te laten spelen met het product waarbij ik anonieme observaties zou maken van hun spel.

Als het je leuk lijkt om je kind mee te laten doen aan dit onderzoek vind je bijgevoegd een informatiebrochure met verdere uitleg en een toestemmingsverklaring die getekend voor vrijdag 21 juni bij de juf ingeleverd moet worden. Als je liever niet hebt dat je kind meedoet aan het onderzoek is er alsnog mogelijkheid voor je kind om met het speelgoed te spelen, hier zullen dan alleen geen observaties van worden gemaakt. In dat geval wordt er ook geen verdere actie van je verwacht.

Voor vragen of opmerkingen kan je altijd contact opnemen via de mail:
r.l.denotter@student.utwente.nl

Vriendelijke groet en bij voorbaat dank,

Rachel den Otter

FIGURE D.1: Short introductory information letter

## D.2 Brochure

An information brochure has been given to the parents with all relevant information. It was printed on A4 and folded twice to create a brochure, Figure D.2 shows the back in the middle and the front on the right. Figure D.3 shows the inside with most of the information.

**Worden er gegevens publiek gemaakt?**
De gepubliceerde observaties zullen niet traceerbaar zijn naar personen. De getekende toestemmingsformulieren worden veilig bewaard. Na de sessie zullen de naam en handtekening van het formulier vernietigd worden zodat u niet traceerbaar bent als deelnemer.

**Kan ik mijn gegevens laten verwijderen?**
Als je tijdens of direct na een activiteit besluit dat je niet (meer) wilt meedoen worden al je gegevens van die sessie verwijderd. Als de onderzoeksmaterialen eenmaal anoniem gemaakt zijn kunnen ze niet meer aan jou gekoppeld worden en kunnen ze dus ook niet meer verwijderd worden

**Meer informatie en onafhankelijk advies.**
Wil je graag onafhankelijk advies over meedoen aan dit onderzoek, of een klacht indienen? Dan kan je terecht bij Petri de Willigen, secretaris van de Ethische Commissie (tel. 053-489 2085, ethicscommittee-cis@utwente.nl). Deze commissie bestaat uit onafhankelijke deskundigen van de universiteit en is beschikbaar voor vragen en klachten rondom het onderzoek.

Voor vragen kan je verder terecht bij de onderzoeker en begeleider van het onderzoek; contactgegevens op de achterzijde van deze folder. Dit geld ook als u geïnteresseerd bent in de resultaten van het onderzoek.

**Contactgegevens**
**Onderzoeker:**
Rachel den Otter
r.l.denotter@student.utwente.nl
**Begeleider:**
Dennis Reidsma
d.reidsma@utwente.nl

**UNIVERSITY OF TWENTE.**

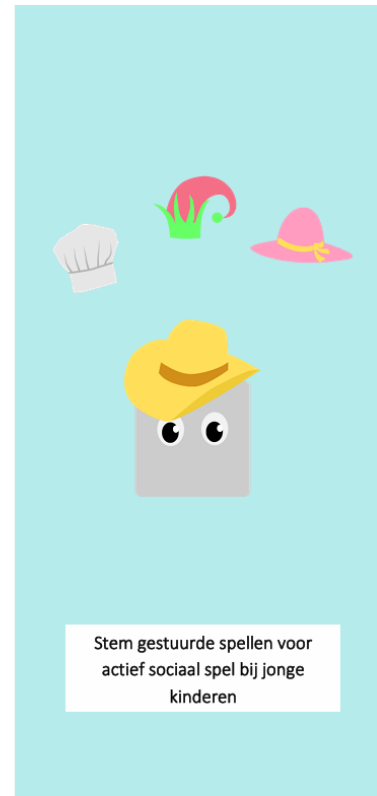Stem gestuurde spellen voor actief sociaal spel bij jonge kinderen

FIGURE D.2: Front and back of the brochure

**Achtergrond**
Veel kinderen zijn tegenwoordig niet actief genoeg. Dit kan tot grote problemen voor hun fysieke en mentale gezondheid leiden. Hoewel veel apparaten en apps proberen hen te motiveren om meer actief te zijn, blijft het moeilijk om kinderen in beweging te krijgen. Sommige van deze technologieën richten zich te veel op fysieke activiteit en negeren andere cruciale aspecten in kinderspel, zoals plezier hebben, creatief zijn en socialiseren met vrienden. Het is essentieel om manieren te vinden om kinderen te stimuleren actief te zijn, terwijl ook rekening wordt gehouden met hun emotionele en sociale behoeften.

Als afstudeeronderzoek voor de Bachelor Creative Technology aan de Universiteit Twente ontwerp ik een apparaat waarmee kinderen worden uitgedaagd om mee te doen aan fysiek sociaal spel door middel van audio aanwijzingen. Het apparaat is bedacht met het idee om drempels in spel te verlagen en kinderen betrokken te houden door middel van spraak.

**Onderzoeksprocedure**
Door middel van observaties en een kort interview zal informatie verzameld worden over de interactie van kinderen met het ontworpen product. Deze informatie zal anoniem gebruikt worden voor de evaluatie van het bachelor onderzoek. Voor vragen kunt u contact opnemen

met Rachel den Otter via de contactgegevens op de achterkant.

**Deelname**
Deelname is volledig vrijwillig en kan plaatsvinden als er een getekend toestemmingsformulier is ingeleverd. Je kunt op ieder moment, zonder opgaaf van reden, aangeven dat je niet meer wilt dat je kind meedoet. Als een kind tijdens de sessie zelf besluit niet meer mee te willen doen wordt dit ook gerespecteerd.

**Wat gebeurt er tijdens de sessie?**
De sessie betaat uit twee delen en zal in een groepje met klasgenootjes plaatsvinden.

In het eerste deel maken de kinderen kennis met het product en spelen ze spelletjes. Het product bestaat uit een zogeheten 'voice agent' die audiofragmenten afspeelt waarbij kinderen worden gestimuleerd om samen te bewegen. Kinderen krijgen een polsband die een dier symboliseert die ze bij de voice agent in de buurt kunnen houden om deel te nemen aan het spel. Kinderen kunnen vervolgens zelf kiezen welk thema het audiofragment heeft door een thematisch hoedje op de voice agent te plaatsen. In de audiofragmenten worden de kinderen uitgedaagd om fysiek actief mee te doen door bepaalde bewegingen na te doen en worden ze aangesproken als het karakter wat hun polsbandje heeft.

Het tweede deel van de sessie bestaat uit een kort interview waarbij de onderzoeker de kinderen vraagt wat ze van het spel vonden. Hierbij zullen audio opnames worden gemaakt die binnen twee dagen anoniem getranscribeerd en vervolgens verwijderd worden.

**Hoe worden de gegevens gebruikt?**
De observaties en bevindingen worden gebruikt als evaluatie voor een afstudeerproject. De bevindingen zullen volledig anoniem opgeschreven en gepubliceerd worden.
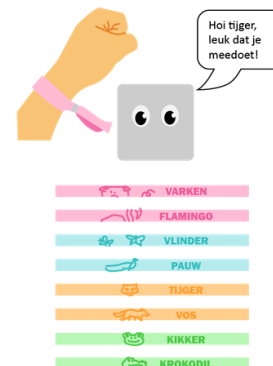
Hoi tiger, leuk dat je meedoet!

VARKEN
FLAMINGO
VLINDER
PAUW
TIJGER
VOS
KIKKER
KROKODIL

FIGURE D.3: Inside of the brochure

## D.3 Consent Form

Finally, a consent form was provided for the parents to fill in and hand back to the teacher before the testing moment, this is shown in Figure D.4.

**TOESTEMMINGSVERKLARING (INFORMED CONSENT)**

**Betreft**

Onderzoek van een afstudeerproject van de Universiteit Twente naar de inzet van spraak gebaseerde spellen in het stimuleren van fysiek actief sociaal spel, zoals uitgelegd in de informatiebrochure "stem-gestuurde spellen voor actief sociaal spel" die bij dit formulier is gegeven.

**Toestemming over onderzoek**
Ik verklaar hierbij het volgende:

- Ik verklaar hierbij dat ik volledig geïnformeerd ben over het onderzoek. Het doel van het onderzoek en de methodes zijn mij uitgelegd, waarbij ik de ruimte heb gehad om vragen te stellen via de contactgegevens.

- Ik begrijp dat ik de deelname op ieder moment, zonder opgaaf van redenen mag en kan beëindigen zonder dat hieraan enige consequenties verbonden zijn.

- Ik geef hierbij toestemming voor deelname van mijn kind aan onderzoek op 21 juni en voor het verzamelen en gebruik van anonieme gegevens zoals beschreven in de informatiebrochure.

- Ik geef toestemming voor het mken van audio opnames voor onderzoek doeleinden

Audiomateriaal wordt enkel door de onderzoeker beluisterd en zal direct na het anoniem trancsriberen, binnen twee dagen na het onderzoek, verwijderd worden.

- · Ik geef toestemming voor het publiek beschikbaar stellen van de anonieme onderzoeksmaterialen die zijn verzameld tijdens mijn deelname aan het onderzoek

Datum: _____          Plaats: _____

Naam kind: _____

Naam ouder/verzorger_____   Handtekening: _____

FIGURE D.4: Consent form to be filled in by the parents

On the day of testing the children were also given a colouring page of the play puppy and hats to introduce the activity and give them something to bring back home as a gift for participating. All the children received the colouring page, also if their parents didn't sign the consent form and they only played with the voice agent without participating in the research. The colouring page is shown in Figure D.5
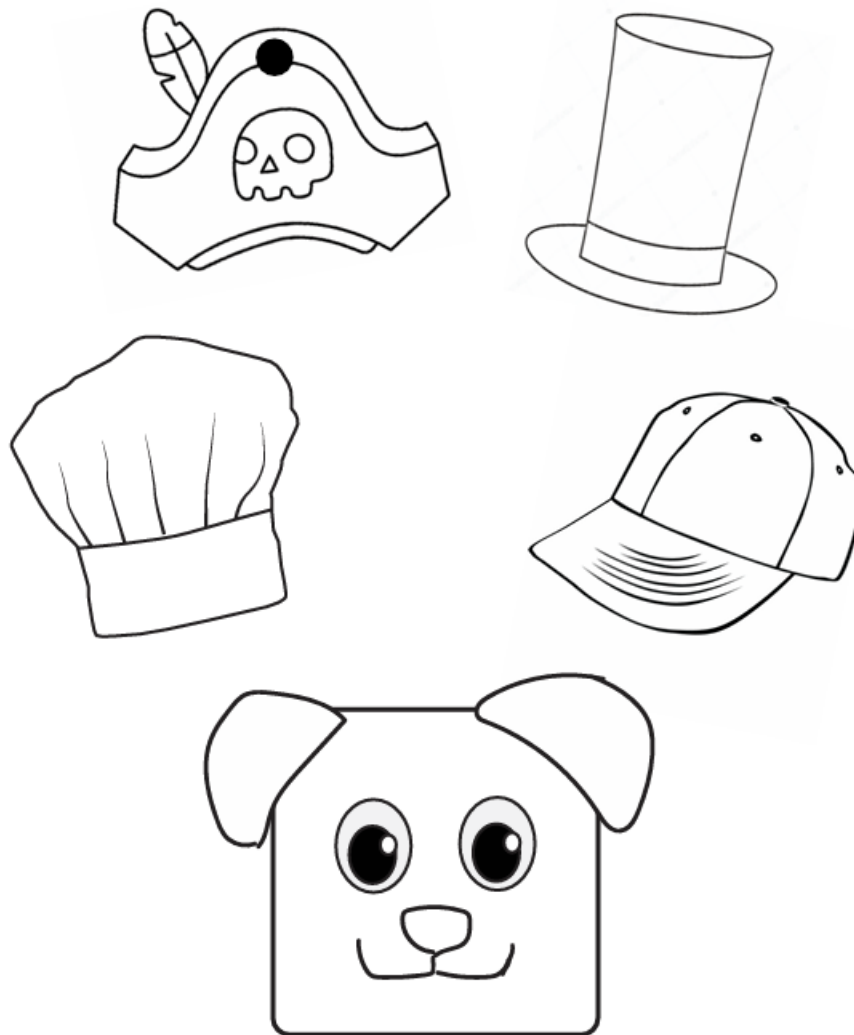
FIGURE D.5: Colouring page handed out to the children

# Appendix E

# Observation Canvas
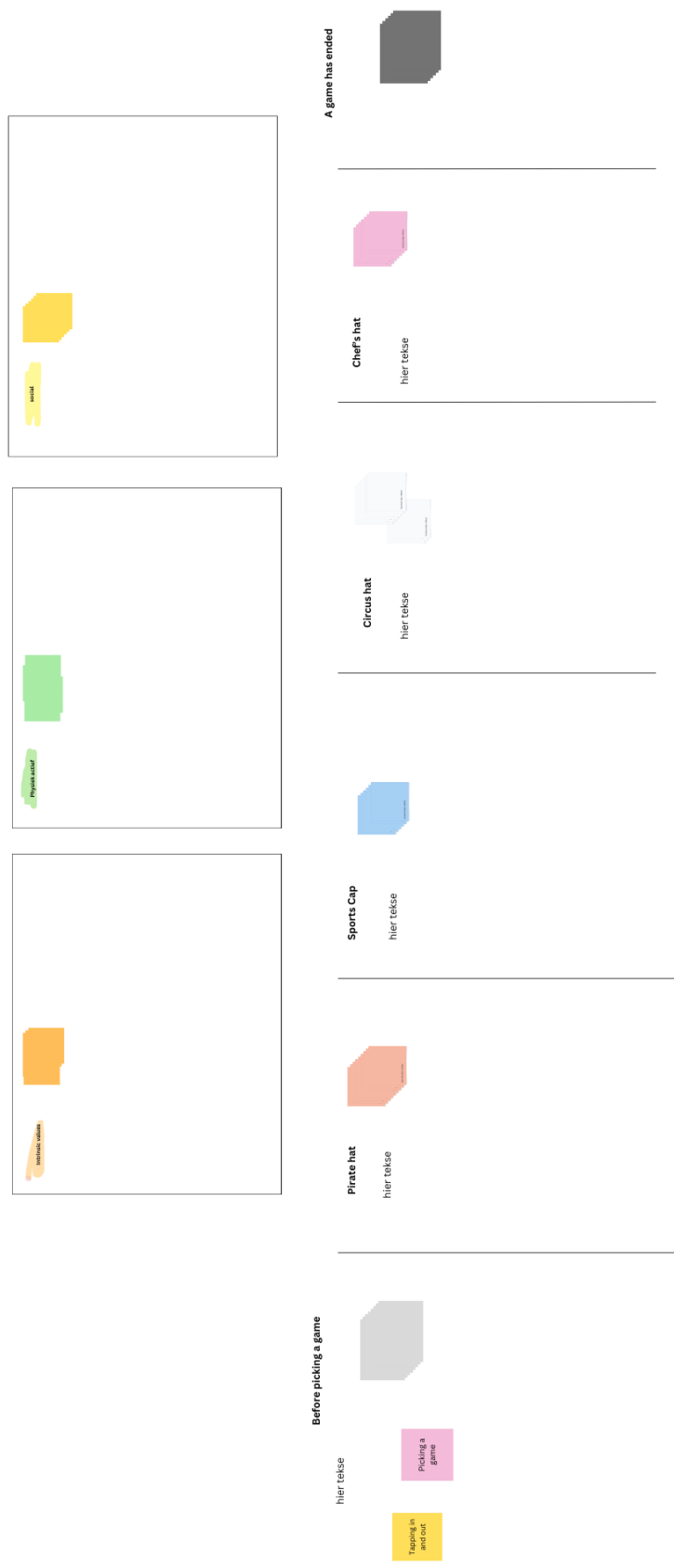
FIGURE E.1: Observation canvas used to take notes during the user test

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