Daddy, You Can Be the Fox: Designing Hybrid Playgrounds for Nature Integrated Storytelling

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Abstract

Using Research through Design, this paper explores how to design a technology augmented outdoor playground installation that utilizes storytelling to create engagement for local wildlife and ecosystems. Through a multisectorial design project a permanent playground installation was developed, implemented, tested and evaluated over a period of six years. The installation is a small play hut, integrated in the natural landscape and augmented with interactive audio stories. The installation was found to invite extended and recurring use, for children and families. The stories and their content seemed to engage children, and they also readapted them through story-informed play. Creating meaningful interactivity proved challenging, as it caused confusion and broke storytelling immersion. We suggest the strong concepts of designing for Story-Informed Play and the Unique Opportunity Effect. Other design implications include to design for; qualitative story content, robustness, playification, screen-free interaction, ambiguity, malleability, intuitive use, multi-user, and extending the experience beyond the installation.

CCS Concepts

• **Human-centered computing**; • **Human computer interaction (HCI)**; • **Interaction design**;

Keywords

Research through Design, Playfulness, Interactive installations, Audio Storytelling, Nature experiences, Playground design, Implemented design

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1 Introduction

Playgrounds are seldom seen as a type of media, despite the fact that they tend to be an arena for experiences, and for creating and recreating stories [82, 107]. New possibilities of technology augmentations and Internet of Things opens up for new types of experiences at playgrounds, for instance connected to interactive storytelling [10, 33]. Storytelling is a powerful way to create engagement [113], especially to utilize interactive storytelling for children [42]. Storytelling can for instance create engagement for local nature and wildlife [20].

Outdoor play and playgrounds are important sites for children's development, early years experiences and for opportunities to experience local nature [31, 62, 93]. Experience design at playgrounds tend to be very traditional and rigid [36, 76, 108], as well as disconnected from the natural surroundings [51]. The few, but increasing, examples of existing technology augmentation of playground equipment often stay at simple games of pushing buttons or activating lights [59, 78, 89]. There is a large potential, and well-designed technology enriched playgrounds can be beneficial for children's learning [94]

Using a Research through Design approach, this paper looks at how a technology augmentation playground installation can be designed to provide possibilities for interactive nature integrated storytelling, using a play hut with built in narration technology as its main example.

As part of this research a permanent outdoor public playground installation was designed and implemented at a permanent public outdoor playground. The design was evaluated through qualitative observations of children's play behavior, as well as through interviews with parents and children.

2 BACKGROUND

Children spend more and more time indoors, and also increasingly in front of screens [48, 100]. Thus, technology can be seen as problematic in relation to outdoor play experiences for children, but it could also be utilized to promote it. Well-designed technology augmented playgrounds can provide meaningful experiences and engage children [10, 94], and play is crucial for children's development [6, 41, 87, 106].

2.1 Technology Augmented Playgrounds

Playgrounds are important as providers of play opportunities [51, 51, 73, 76, 81, 108], but playgrounds tend to be rigid, traditional and poorly designed [36, 76, 108], often mass produced and lacking connection to the local environment [51]. Technology augmented playground installations are beginning to emerge, and is a comparably new phenomena [38, 59]. The solutions available on the market today are typically quite simple, with buttons, LEDs, and sometimes sound feedback and different types of minigames provided [78, 89]. This shows great potential for improvement, and playground professionals foresee that the Internet of Things

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and similar technologies will heavily affect the way we design and experience playgrounds in the future [59]. For instance, technology augmented playgrounds could utilize storytelling to create engagement and learning opportunities in relation to Nature, as in the focus of this study.

2.1.1 Research on Audio Storytelling Hybrid Playgrounds. There are many interesting cases within the HCI community of research concerning hybrid playgrounds, here, in a non-exhaustive way, some examples are presented. There are many publications on interactivity in playground installations [9, 32, 33, 77, 91, 95, 96, 101, 102]. There are projects on smart playgrounds, and how to successfully design interactive outdoor playgrounds [102]. Research through Design projects include for instance interactive slides [101] and interactive small-scale playground installations with mini-games [33]. There are publications on playful learning through technology enhanced playgrounds [94], and there is research on how to build values into technology augmented playground design, where important values listed include storytelling, playfulness and interactivity [10].

There are publications focused specifically on sound experiences at playgrounds, and audio enhanced playground installations, for instance the work of Hug et al on sonic playground equipment [53]. Rather than focusing on audio stories, their focus is on sound effects. There is also research on storytelling in relation to playground installations, such as the Dragon School prototype described by van Delden et al, where a story is played out through interactions with physical installations, this was combined with a small audio story, even though the storytelling part was not the main focus on the study [33].

The installation described in this paper is partly described in other publications, but then as a part of a larger research project, and not with the specific installation described in this paper as the main focus [9, 10].

To the authors knowledge there are no Research through Design exemplars of research on playground installations focusing on technology augmented nature integrated playground installations that utilizes audio and interactivity to provide nature storytelling experiences, as is the scope of this paper.

2.1.2 Hybridity as a Type of Technology Augmentation. Creating a digital-physical hybrid playground installation, the concept is closely related to mixed reality. And, as with mixed reality, hybrid experiences exist on a spectrum from mostly digital to mostly real world [75]. XR, extended reality, can be seen on a *virtual continuum*; from completely virtual to completely real environments [39]. Technology augmentation of physical installations, as in this study, is on the virtual continuum, but closer to real environments, often with subtle technology enhancement, such as audio or light effects.

While hybridity in experience design may refer to several types of overlaps [8], here we mainly focus on hybrid experiences as "installations that support visitors manipulating physical and digital material in a visible and interesting manner" [11]. The paper focuses on augmenting physical installations through technology, utilizing output such as audio and lights, and input in the form of different kinds of sensors and buttons. The focus is on embodiment and on-site exploration enhanced by technology, as opposed to e.g. a digitally focused experience on-screen, such as in a smartphone app. This paper focuses on installations that are not merely a screen placed in a physical environment, but a designed physical installation with spatial and embodied properties, and with technology built into it.

2.2 Storytelling

Storytelling is deeply integrated into human culture. It is a way for us to make sense of the world [49, 90]. Storytelling is about meaning making, engagement, how the story is told, and in what medium it is told [74].

Storytelling for children, especially if audio driven, is a powerful way to create immersion, train imagination, learn and gain understanding [49, 109, 113]. It has been known for long that stories affect children's play, and that children in their play recreates stories from media [82, 107]. So, by providing access to engaging stories, their play can also be affected and enhanced.

2.2.1 Storytelling at Playgrounds. Playground installations are seldom seen as a type of media. But it is a unique arena for experiences for children and families, where narratives and stories can be communicated through the design, architecture and embodied play installations. This has become more and more apparent with the increase of thematic playgrounds, telling specific stories through their design [99]. In a way it can be seen as mass communication, since the narrative from the designer/developers of the playground is conveyed to many children, especially for off-the-shelf playground equipment, and playground companies design for storytelling [3, 24, 115]. At the same time children, through their play, makes their own interpretations and creates new and other narratives [82]. There is a relation between play and storytelling, looking at Hughes play taxonomy several play types include storytelling aspects; for instance, imaginative, dramatic, sociodramatic and fantasy play. [54]. Despite their importance, good playground design is often neglected, and typically mostly caters for physical play, ignoring many other play opportunities [73].

2.2.2 Audio Driven and Interactive Storytelling. Making storytelling experiences that relies mainly on audio requires special attention to both the narrative and audio, tying into audionarratology [56]. Sound can be a powerful way to create immersion, and emotional engagement, allowing us to construct our own pictures in our heads, rather than relying on external visualizations [18]. This can be enhanced by for instance dialects and good narration [19]. Audio stories, such as pods and audiobooks, are increasing in popularity [18]. But they tend to be linear in their storytelling.

Including elements of interactivity in storytelling requires the creation of story trees, to manage the choices of the story, thus utilizing non-linear storytelling [86] and microstories [85]. Especially interactive storytelling can create positive effects on learning, and here mixed reality technology can play a role [5], but there is also a dichotomy between storytelling and interactivity, as interactivity challenges the narrative [1]. Since the 1980s Interactive fiction has been used as a term for storytelling that utilizes digital possibilities to create interactive stories [79, 111]. Interactive fiction today is a rather big genre, flourishing especially in online communities [57]. Interactive fiction and storytelling have gained attention in the HCI community, and interactive storytelling for children is of special interest [42]. The increased possibilities of technology augmented playgrounds [33, 38, 59, 94] opens up for digital interactive fiction to be combined with the embodiment of the playground installation, something that would require a special type of interaction design.

2.3 Playfulness, Learning and Immersion

Playing is an important part of being human. It is an activity as old as culture itself, and an activity worthy of its own value [29, 55, 98, 103]. Play is also a way of learning new things, without too much risk to neither health nor status [4, 14, 88]. In different forms, we play all throughout life, and it helps us to create a low-stakes space [46, 55] where we dare to try, to be right, to be wrong, and to experience new things. Especially for engagement in public environments play can be powerful, and it can be enhanced through technology augmentation [2, 7, 80, 104].

It is not uncommon for gamification and technology enhanced play to have a strong emphasis on the gamistic elements of play, focusing on rules systems, points, badges and leaderboards [34]. According to Gaver, there is a distinct difference between Games and Play, where play has much more focus on intrinsic motivation and curiosity, not on competition [44]. In this work, we focus on playful design rather than gamistic, and play as an engine for learning, this connects to the concept of playification, where playful elements are used to encourage learning [10, 71].

Within the field of education there it is a well-established fact that there is a clear connection between learning and play [88, 106]. There are international studies showing that technology enriched playgrounds can be beneficial for children's learning, and that the effect is significant, disregarding other factors such as gender and country [94]. Creating such innovative playful learning environments fosters new ways of playing as well as powerful learning [61, 94]. This study focuses on informal learning [21, 30, 93] and playgrounds are an important arena for children's informal learning [21, 93]. Play at playgrounds often occur in a social context [16, 47].

Experiential learning [64] builds on that effective learning can be achieved by having experiences and then reflecting upon those experiences [64]. Situated and immersive learning experiences are effective, especially when taking on a playful approach, and they can be created using audio, or for instance different technologies on the mixed reality spectrum [58]. Experiences and immersion create engagement and can enhance the learning process [70, 105]. Narratives can create experiential engagement [28], and engagement is something that can be designed for [110]. Storytelling can be a powerful tool to enhance learning [66] and to create immersion [22, 50]. Movement, spatial aspects and embodiment can also strengthen immersion [50, 84].

2.3.1 Nature Focused Experiential and Playful Learning. Nature-oriented playground design can promote engagement and learning in relation to nature. [93]. Increased knowledge and understanding of nature also increase interest, and encourages spending more time in nature [17, 62, 72].

It is problematic for many reasons that children today in many parts of the world are less connected to nature and local wildlife [17, 62, 72]. Louv, in his book *Last Children of the Woods*, refer to this as nature deficit-disorder, where children are deprived of outdoor experiences, especially in relation to experiences of and knowledge about local nature [67]. One way of mitigating this is to provide nature play opportunities, and designing play environments that allows for and encourages nature play and exploring and experiencing nature [31, 35, 83]. Designing technology enhanced playground installations utilizing storytelling could provide learning and play opportunities focused on nature and local wildlife, and that is something this study focuses on.

2.4 The Design Project

The design process was part of a state funded innovation and research project. In the project and in the design process some prerequisites were in place, that have affected the design choices. The design group consisted of a triple helix consortium, with representatives from two universities, industry, in the form of tech companies and a sustainable development agency, and the public sector, in the form of a municipality. The project outlines were focused on the Internet of Things and playfulness, and the main target group was children and families. The project focused on sustainable development with special focus on mediating biological diversity. The installation was designed to be a part of a permanent public outdoor playground. The project ran 2018-2021, and then after-studies have been made.

3 Method and Methodology

This study takes on a Research through Design (RtD) approach [112], treating the whole design process as a producer of knowledge, and acknowledging that the artifact in itself contains knowledge, rather than only through for instance user evaluations [13, 15]. The paper presents and analyzes a design of a permanent hybrid storytelling playground installation, combined with qualitative In the Wild observations [97], and the paper contributes with intermediate level knowledge in the form of design implications and strong concepts [52].

As an active part of the multisectoral design group [65] researchers have followed the project during three years of development, and then follow up studies for three years after inauguration of the playground. At least one researcher was always present at work group meetings, held once a week throughout the process, as well as in most other meetings, workshops, testing etc. As emergence can be seen as a core feature of RtD [45], this paper is a try to convey a coherent picture of an emergent and not so coherent design process.

The paper uses multimethods [26], with data and documentation supporting both research and design, in a generative process [12]. Data was gathered throughout the design process, in the form of for example meeting notes, shared online workspace resources, sketches, documented prototype tests and pictures. The finished design was studied in-the-wild [97] giving opportunity to see natural play behavior. This was combined with small on-site interviews, utilizing Walk-and-Talk methods [63, 69, 92], where children showed how they played, while talking about it, providing room for non-verbal communication and on-site contextualization. The material was analyzed using a topical narrative method approach [114] and thematic analysis [25, 27]. Annotated portfolio method has been used to analyze and present knowledge built into

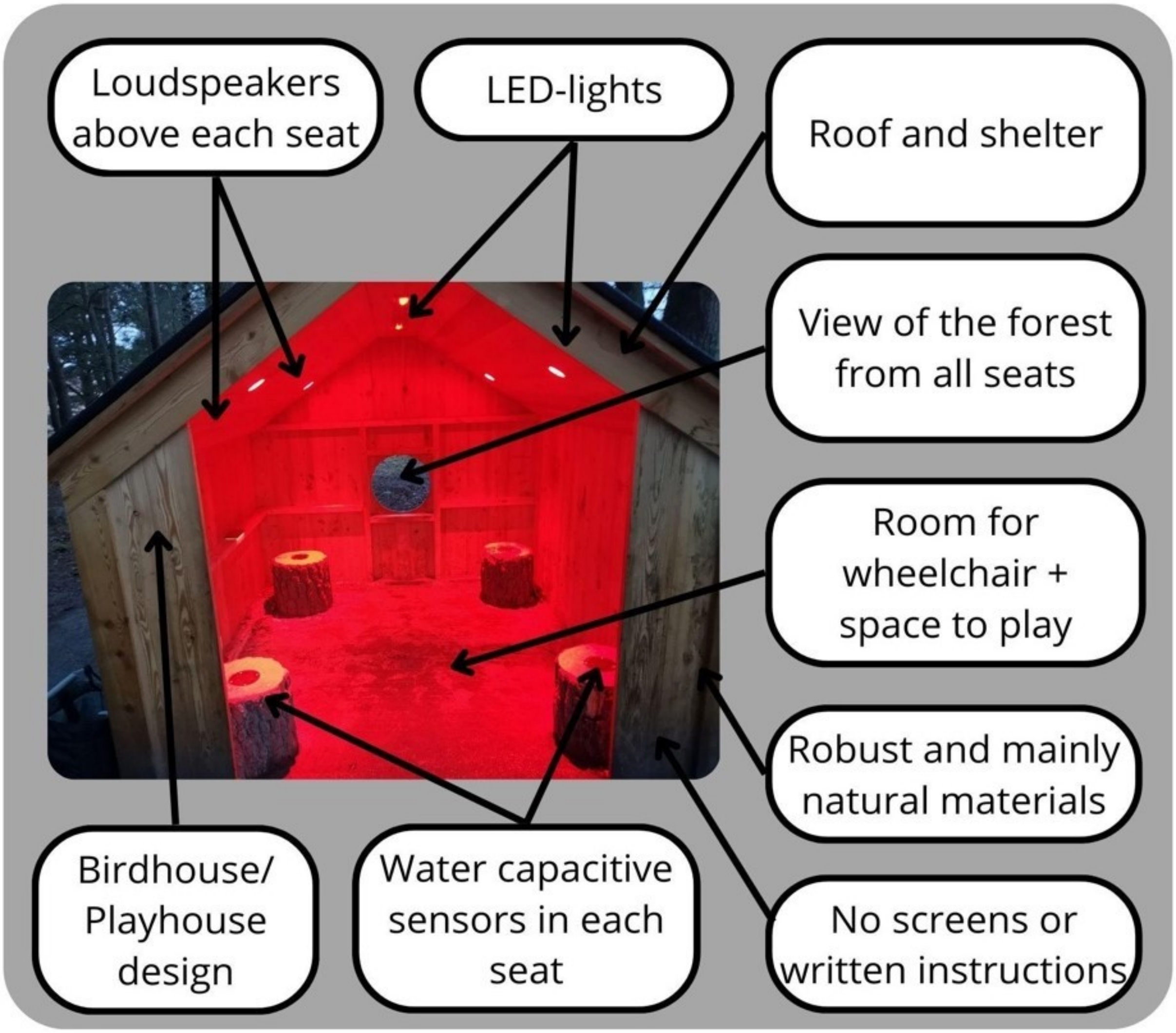

Figure 1: Annotation of the physical appearance and hardware for the installation

the design [23, 43, 68]. For the observations Thick Description was used, both as representation of the data, but also guiding the research process, as described by Freeman [40].

Ethical considerations in this paper are mostly related to the observations at the finished playground. Since no personal or sensitive data was collected, it was assessed that no formal ethical approval was needed. The observations were conducted in a public space, and although observing behavior, it was limited to ordinary play behavior that would occur with or without the researchers present. As children seldom visit this location by themselves, we were able to inform both children and accompanying adults about the study, and they gave oral consent to being observed and interviewed. The pictures of children in this paper are from a promotional photoshoot arranged by the municipality, and they are not depicting research subjects.

4 Design: THE STORY HUT

The Story Hut is designed as a small wooden hut, a kind of playhouse as seen in figure 1, containing technology in the form of sensors, lights and loudspeakers, all robust industry products. The installation is permanently built at the playground, and fulfills all EU safety requirements for playground equipment.

4.1 Design for Integration in the Natural Surroundings

The installation is part of a bigger nature-themed playground, consisting of a range of play equipment, including the Story Hut and two technology augmented play eggs, among many other installations (See figure 2). In this paper we will focus entirely on the hut, and how it is used for storytelling, the eggs are mentioned for completion.

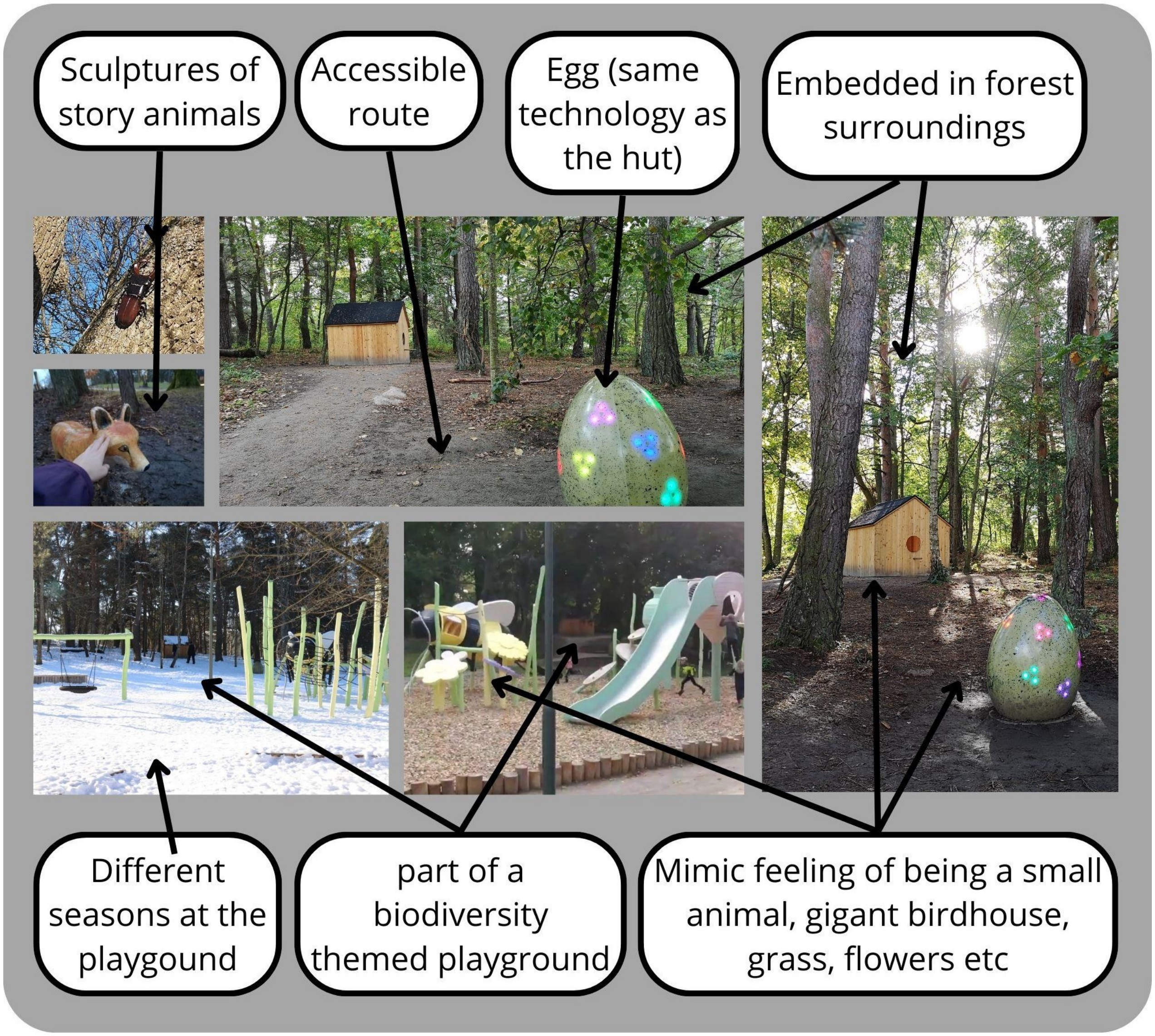

Figure 2: Annotation of how the Story Hut relates to its surroundings

4.2 Interpersonal and Inclusive Design

At the playground typically several persons play at once, something that the design tries to cater for. The installation has 4 seats with sensors to sense when someone is sitting there, and an interaction design adapted for multi-use. Further it is designed to be accessible, for instance by being intuitive and by wheelchair access. Being audio driven the installation is not designed for hearing impairment, which is a drawback and problematic from an inclusion perspective. The physical installation in itself is built to be welcoming for many persons at once. The interpersonal and inclusive design features are annotated in figure 3.

4.3 Designed for Malleability and Changeability

The Story Hut is designed to provide new story experiences every time you visit the playground. The installation is designed to be interactive, by activating the seat sensors (i.e. moving from one seat to another) users can change perspectives in the stories, thus creating a unique story experience. The scenarios also run on a calendar; only the current seasons stories are available at any given time, and there are triggers for different weekdays, each day you get a different starting story.

The hut is an IoT (Internet of Things) installation, connected to the internet. The installation is complemented with a custom developed programming tool, annotated in (figure 4). The tool makes it easy to add, change and tweak scenarios. Scenarios is the

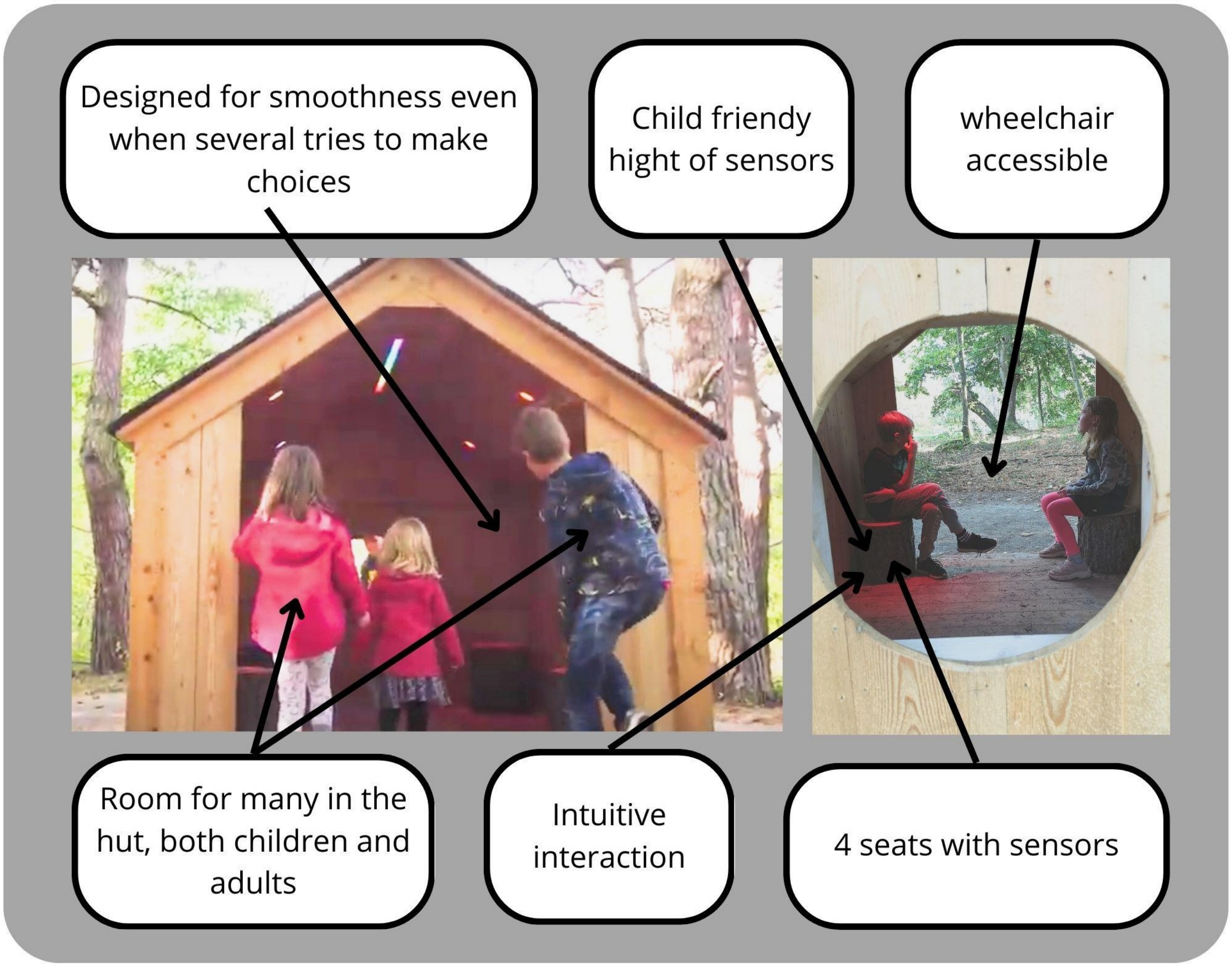

Figure 3: Annotation of interpersonal and inclusive design features

name used for the "games" of the Story Hut, the gameplay; you activate a scenario, and then you experience it. The story snippets remain the same, combined in different ways. It would be possible to add new story snippets, but that would require external audio recording and integration. The online interface and installation are prepared for the possibility to connect other installations to it, and to make them affect each other in different ways.

4.4 Stories and Scenarios

All stories in the hut are designed for story-driven nature experiences, and are related to animals. The animals chosen for the stories are wild species with habitat in the local area. The stories have been written by a professional children's book author specialized in writing fact-rich children's books about sustainable development, nature and biodiversity, and the stories have been reworked by an editor specialized at non-linear storytelling. The stories are written from the animals' perspective, each animal with a separate narrator. The stories are in Swedish and narrated by professional voice actors, celebrities chosen for being known to children, and for having good narrating voices. Importantly, the stories are not fables and the animals are not anthropomorphic. The stories' descriptions of animal behavior are representations of their actual behavior such as hibernation, movement patterns, feeding and nesting. Emotions expressed by the animals in the stories are emotions you can read from their behavior or instincts. For example, the fox got angry and his hackles went up, or the earthworm felt hungry and began to eat. The animals are given names, to mark them as individuals, just like you might name a squirrel you see every day outside your window.

The stories focus on the animals in relation to the local ecosystem. For instance, the bird who steals nuts hidden by the squirrel, The bumblebee queen hibernating when the snow comes, the fox chasing the hare, and the earthworm sharing a leaf pile with the hedgehog. Correct species names are used, for instance not just any beetle but a specific type of beetle. Below is an annotation

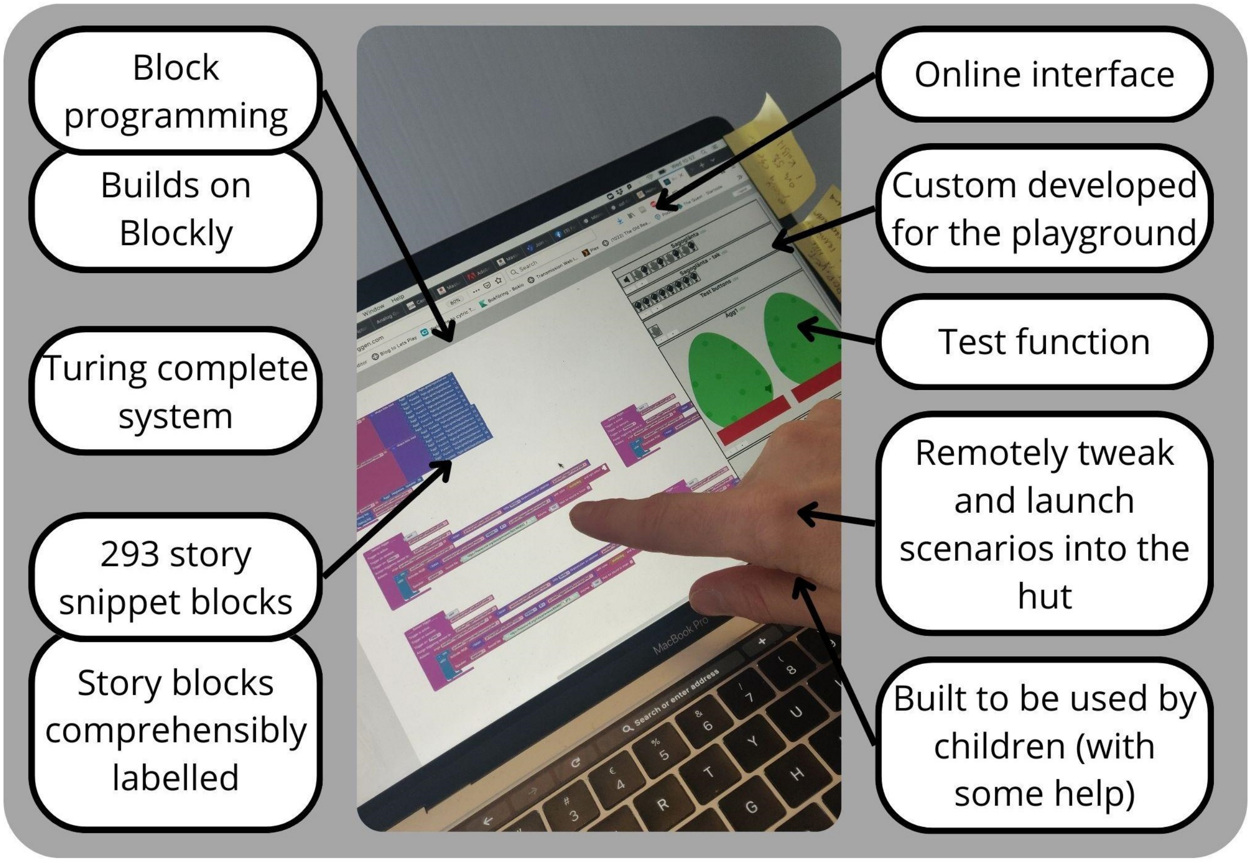

Figure 4: Annotation of the programming tool for the Story Hut.

of the design features related to providing a story driven nature experience (figure 5)

4.4.1 The Scenarios and Story Modes. The main interaction in the Story Hut are the storytelling scenarios. When not in use the Story Hut has a rainbow light in the middle of the roof and from time to time there is a small shout out, a narrated audio snippet to encourage people to go into the hut. When activating a seat sensor a story scenario is activated. All the story scenarios build on the same collection of stories, broken into 293 story snippets. The snippets are separate audio files, each around 15-30 seconds long, meant to be combined in non-linear storytelling. The story snippets are arranged by animals, with 9 different animals (see figure 6), such as hare and fox. For each animal, the story snippets are arranged into four seasons (for instance, 'The Fox' - 'Summer'). Within each of these animal-season-groups, there are one or more named short story arcs, each consisting of around 3-10 snippets (for instance, 'The Fox' - 'Summer' - 'Roffe the Fox get lost'). For many of the stories there are different versions of the same story snippets, but from other animals' perspectives. Such as 'The Hare' - 'Springtime' - 'Hanna the Hare gets chased by Roffe the Fox', and its counterpart in the Fox's story: 'The Fox' - 'Springtime' - 'Hanna the Hare gets chased by Roffe the Fox'. Example of a story snippet can be found in table 1. The story snippets make it possible to rearrange the stories in different forms, depending on the scenario. Below follows a description of implemented scenarios that are or have been active in the playground installation.

4.4.2 The Inaugural Scenario (Autumn 2020). This was the first scenario implemented. Depending on which color the light spots are showing when sitting down a different autumn story starts. The colors represent different animals, for instance red light will start the story of the fox, and blue light will start the story of the earthworm. There are no instructions about this but rather something to figure out by trying. In the stories one or several animals are mentioned. Towards the end of the story snippet (or small collection of combined snippets) one or several light colors flashes in the roof over one or several of the seats. You can change animal's perspective of the story, by moving yourself to another seat. By staying, you keep following the story of your chosen animal. This enables for instance giving the perspective of both the Fox and the Hare during a hunt.

4.4.3 The Advent Calendar (December 1 - December 24th). The advent calendar consists of story snippets from the winter stories,

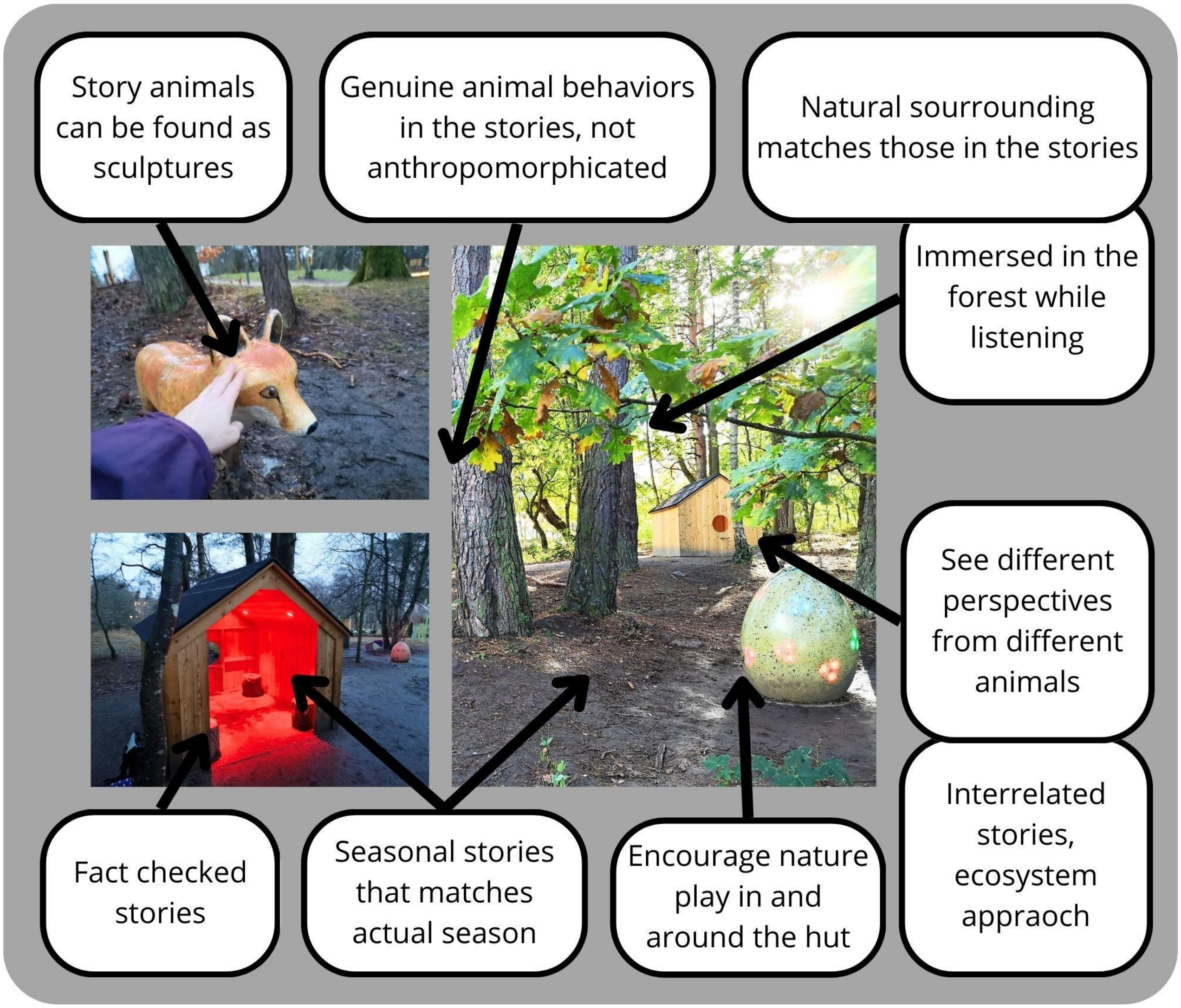

Figure 5: Annotation of Design for Story Driven Nature Experiences

combined into mini stories (around 3 minutes each). Each day until Christmas a new mini story becomes available. After hearing the story of today you also get a chance to choose to listen to the previous mini stories of the advent calendar.

4.4.4 Story of the Day (Yearly: December 25th - November 31). This is the scenario that is most commonly active at the playground. It was created based on feedback on the inaugural scenario. In the Scenario Story of the Day seasonal story snippets are combined into mini stories (around 3 minutes each). 9 such mini stories are available. Each day, the scenario begins with a new starting story (out of the nine stories). Then you have the option to listen to the other eight stories. This scenario is more linear, and contains less interactivity.

5 Observations and Reflections

The Playground was inaugurated in October 2020 and the Story Hut has been active and functioning since then (at time of writing, August 2024). As the installation is internet-connected it has been possible to measure how much it has been used. During two weeks in February 2021 every interaction was logged, showing that the story scenario had been activated 196 times. During this period, it was cold (below 0 degrees Celsius), snowy and a rather harsh climate to spend at a playground, but still the hut was used.

The playground has been observed by researchers at several occasions after the playground's inauguration, both in more authentic and natural play situations, as well as by inviting larger groups of children to play. To give an overview of observations, it was common to see children just running into the hut and running out again, especially when larger groups of children were engaged in

Table 1: An excerpt of story snippets from one of the springtime stories (article authors translation).

Springtime story: Hanna the Hare gets chased by Roffe the Fox	
Hanna the Hare	Roffe the Fox
Snippet 1: Hanna the Hare and Kurran Longtail [the squirrel] were in the forest glade, looking for food. Hanna the Hare sniffed in the air. There was something that was not right. There was a danger nearby. What could it be? What could it be? Just hope it is not a fox, one like Roffe or Rutger.	**Snippet 1:** Roffe the Fox sat up at the edge of the forest, which was his territory, and looked out over the glade. A little lark flapped into the sky and chirped at full blast. Roffe licked his mouth, a lark is a real treat to eat, but it wasn't as good as a hare. Hare was the yummiest thing Roffe knew. Imagine if he could catch Hanna the Hare. But Hanna the Hare was too quick and clever. Roffe the Fox had almost given up the idea of catching her. **Snippet 2:** Roffe saw his rival and nearest neighbor, Rutger Fox, come tripping across the glade. The glade was Rutgers territory. Sometimes Rutger came into Roffe's area, then there was a fight so that tufts of fox fur flew around. They constantly watched over each other and competed for everything. Both were looking for the same prey. Something like Hanna the Hare. **Snippet 3:** So, Roffe got an idea, maybe he and Rutger should help each other with the hunt? Roffe the Fox wagged his tail and licked his mouth. It was a sign to Rutger that they should hunt together. Rutger was happy to. They stood guard on either side of the glade and lay down waiting. Would Hanna come today? **Snippet 4:** The foxes were lucky, double lucky! Both Hanna Hare and the squirrel Kurran Longtail came jumping in the grass. They started darting around as if in a dance, while chattering. The foxes crept towards them, careful and close, close to the ground. The grass swayed, the whiskers trembled on Roffe the Fox, Rutger licked his mouth.
Snippet 2: Hanna the Hare suddenly saw the foxes sprinting from the forest down towards the glade. She jumped in one direction and Kurran in the other.	**Snippet 5:** Hanna sat on her butt and looked around. Both she and Kurran sensed that there was danger nearby. The foxes understood that they would be discovered. That's why they set full speed against the hare and the squirrel! Hanna and Kurran saw them and quickly jumped off in different directions. The two foxes became very giddy, who would they follow? They decided to run after one animal each. Roffe the Fox followed Hanna, and Rutger ran after Kurran.
Snippet 3: Roffe the Fox followed Hanna. She zigzagged like a cannonball to an old badger hole. There she dove down. She heard how Roffe the Fox tried to bore down into the hole. How terrible!	**Snippet 6:** Hanna Hare zigzagged like a cannonball to an old badger hole, where she dove down. Roffe the Fox followed and tried to bore down into the hole. Hanna dug deep, but Roffe got stuck at the start. He could neither get down nor up. Hanna poked her head out of another hole. She had gotten away, again.
Snippet 4: Hanna kicked with her hind legs and scratched her paws. It was vital that she buried herself deep down, so that Roffe the Fox wouldn't get hold of her. She lay still, pressed to the ground, for a long time. But nothing happened. Hanna crawled out of a hole a little further away, and stuck her head up to see if the danger was over. Then she saw that Rutger the fox was stuck in a tree, and Roffe the Fox was stuck in the opening to the badger's hole. He could neither get down nor up.	

physical play. There were also cases of children using the hut like an ordinary playhouse, or hiding in it during hide-and-seek, not activating the stories. But there were also several observations of play occasions involving the stories. This paper focuses on a collection of qualitative observations of such play occasions involving the stories, taking place as part of natural play behavior, combined with small on-site interviews in the style of walk-and-talk as described in the method section. The logging of scenario usage, as well as the fact that other studies has been made of the playground, for instance with larger invited groups of children, is mentioned here for completion, but is not in focus in this paper.

Figure 6: An illustration put together for the playground project, of the animals presented in the story snippets

Below key examples of observed play occasions relating to the Story Hut and storytelling aspects of the playground usages is presented. Only occasions where the stories were activated, and the children spent more than around 5 minutes in the hut, has been included. The observations are presented narratively as qualitative thick descriptions, and should not be treated as representative of all interactions. However, they are selected as they describe some of the more typical behaviors seen by the researchers, examples of experiences that *can* be had. The descriptions have been translated into English, checked for anonymity, and for increased intelligibility the language has been polished. Sections irrelevant for the paper have been removed, but otherwise without changing the content in any substantial way. Each observation is followed by a reflection written by the researchers, using a topical narrative approach and thematic analysis.

5.1 Observation 1: Reenacting and learning from the stories

Persons observed: A boy, 5 years old, with his father and grandmother

It is December. During the observation it was rainy and about 5 degrees Celsius, the observation happened in an afternoon. As there was no snow, it was already quite dark outside. It was rather empty at the playground and no other people near the Hut.

The boy is five years old. He visits the playground with his father and grandmother. He had been here once before, the previous day. He was not living in Sweden normally and his first language was not Swedish, but he was fluent in the language.

When the researchers arrived at the playground the boy and his family were sitting in the hut, listening to stories. They sat for a long while, around 10 minutes. While they listened, they had coffee and some biscuits that they had brought along. At this moment the active scenario was the Advent Calendar.

The family came out of the hut after the stories ended. The father told the researcher they had listened to all of the stories available (around 20 minutes of stories). He also told that they had been there the previous day, also listening to all the stories, that was why they had brought coffee and biscuits today. The grandmother pointed out that "he likes calm play" and that he likes to sit down and think. She also tells us that the day before they had heard about a type of bird (a 'grönskrika') in the story "The one that stole the squirrels lunch pack!" the boy exclaims. The grandmother then told, they had to look it up on the phone, because they did not know what that bird looked like.

The boy and father said that after they had listened to the stories the day before, they had play-reenacted the animals the whole evening. The boy told us that "Daddy you can be the fox [pointing at the father]. I was the hare and you chased me". The boy looks very happy telling us this.

As we ask the boy to show how the hut is used, the boy follows back into the hut. He points at the best spot (one of the stumps) and we ask how to start it. He sits down, and the story starts. The boy starts to listen and looks very focused. He comments on the story with exclamations such as "blaaa, eat birch!" and "ha-ha, the hare slides down a slope". He listens for five minutes, not looking at the researcher, but at the roof and out through the opening. After 5 minutes he stands up, still listening intently. This time he stays in the hut for around 10 minutes in total before going out of it. After that he leaves the hut and the family goes home.

5.1.1 *Reflection on Observation 1.*

This observation shows that the user really listens to the stories. Also, that the content about animals and how they relate to each other is understood by the child. It shows that it is possible for a child to listen for a relatively long time and keep being engaged. It also shows that there is a reusability, that the boy wanted to hear the stories several times, and come back for more stories. That they had both played being animals and had looked up and discussed the animals in the stories after listening shows that they had reflected upon the experience and discussed it, as is important in experiential learning. The comments of the boy and the play afterwards show that the boy could relate to, and understand the content of the stories. The interpersonal perspective is shown in how the family members have reflected upon and discussed the stories together. It is notable that they had brought coffee and biscuits for the purpose of eating this in the hut, thus had planned to sit for a long time and prepared the visit with the aim to listen to the stories.

5.2 Observation 2: Unfocused participation

Persons observed: A girl, around 4 years old, with her father

It is a Monday morning, early January. It is light outside, occasionally a light snowfall and a few millimeters of snow on the ground. It is minus 1 degree Celsius. The active Scenario is the Story of Today (Winter stories). A girl is at the playground with her father. There are a few other children and families around.

While the researchers inform the father about the study the girl starts walking towards the hut and says: "Daddy, the hut!" And he replies: "yes, you can go there". The girl stands in the opening of the hut and cautiously looks into it. It is empty. She goes into the hut and soon a story starts, but finishes fast again. The dad goes to the hut and looks through the round hole into the hut.

The sound of the story plays. The girl walks between the stumps and touches them with her hands. She does not seem to concentrate much on the story. She runs around and shouts the name of the colours (from the LED above each stump). She continues for several minutes. After that she goes and looks through the hole in the hut, she hangs out from the hole. Then she walks across the hut and looks out of the hut through the big opening. Then the girl and father leave the hut and go to another part of the playground.

5.2.1 *Reflection on Observation 2.*

This girl had clearly been there before and liked the hut, and she wanted to go there. But she did not seem to engage in the stories, rather just interact with the lights and use it as a playhouse. It didn't seem like there was much of a learning process connected to the stories in this case, even if she seemed to like the installation. It is not clear why, or if she at previous visits had listened to the stories.

5.3 Observation 3: Recurring engagement with the storytelling experience

Persons observed: A Father, a small boy (Less than 1 Year Old) and a daughter, around 3 years old

Same day as observation 2. The father goes with the son and daughter towards the hut. The hut is empty at the moment. The father holds the son, and the daughter says "Come daddy, into the hut!". The father asks "Who do you think it is about today?" The daughter exclaims: "Maybe the Fox!"

The researchers ask the daughter if she has listened to the stories before. She becomes a bit shy, stands next to her dad and smiles and nods. As we ask what she likes most, she exclaims "The Rabbit!" and then becomes shy again. The father sits down on a stump, and the daughter sits down on the opposite side. When seated she says "orange today" and looks at the LED above the seat. Then she listens to the story that starts and says with a happy voice "And Kurran!" then she laughs mirthfully ('Kurran' is the name for the squirrel in the story).

She sits still and listens. Sometimes she comments on the story and the father happily answers. It is calm and tranquil, both father and daughter seem very happy, the son just sits in the lap.

Finally, the story ends and a noise indicates that a new story starts. They stay also for this next story. After the noise the daughter asks the dad to change places, and they do. "Haha, Dagge‼" she exclaims laughing ['Dagge' is the name of the earthworm in the stories] "and lilac, my favorite color!". They sit through this whole story also, very still. After this story the father asks the daughter if they shall change place again, but the daughter says she wants to go to the swings now. They leave.

Afterward the father says that he thinks "the play interactions [meaning the tech installations] outdoors are cool and that the daughter very much likes especially the stories". He adds "we have never seen anything like this".

5.3.1 *Reflection on Observation 3.*

This observation shows that there is a reusability, the daughter had obviously been here before and listened to the stories. It was for her a joy of recognition. That she liked the stories and the installation very much is both confirmed by her dad and apparent in her happy reactions. This case shows that the daughter understands the stories, by her comments. It also shows that she has emotional engagement and relates to the animals in a friendly way. The fact that she chooses to sit for several stories shows engagement. The interpersonal perspective is clear in the way the father and daughter interact with each other.

5.4 Observation 4: Extended storytelling experience, beyond the hut

Persons observed: A Mother and a Girl, 4 Years Old.

It is mid-February, before lunch. A snowy winter day, -6 degrees and sunny. Around a decimeter of snow on the ground. A daughter is at the playground with her mother, they are new to the playground, they had been there once, the day before. The active story scenario is Story of Today (winter stories). At this point the Hut of Stories has one story scenario and one scenario with music, you chose which by touching a sensor.

The child is not very talkative but listens concentrated to the stories. The mother describes that they have listened to the stories once before and that they listened for a long time. She says that it was a bit tricky to start the stories, and that they wanted to hear the stories again. She says that they listened to all the stories "you want to listen to all stories". When we ask why, she answers that it is because you want to know what is going to happen, and because they are good stories. The daughter sits down in the hut with the mother and listens to the stories. The mother says that they wanted to have coffee and biscuits in the hut while listening to the stories again, but that they will not have time for that because they need to leave soon. The daughter doesn't want to leave, she wants to listen to the stories. The mother says that it might have been good with a way to be able to switch off the stories, because it can be hard to get the children to stop listening to the stories and leave the hut, when you are in a hurry or need to go.

Later the mother and daughter run around in the surroundings looking for the animal sculptures. The mother later describes that they try to find all the sculptures from the stories but that they did not know what the specific type of beetle ('reliktbock') looked like. "I have to google it" she said and did so. The mother also describes how she and the daughter had climbed in the wooden flowers (an installation in the traditional playground next to the hut) and that the daughter had pretended that they were super small, riding on a bumble bee, flying to a small wooden hut with stories in it.

5.4.1 *Reflection on Observation 4.*

Here it was clear that they enjoyed the stories, both because they listened for a long while, and that the daughter did not want to stop listening. That the daughter initiated fantasy play, involving both animals and the hut, shows that she has understood the theme and reflected upon it, thus being in a process of experiential learning, with both an experience phase and a reflection phase. That the hut had inspired to learn more and further investigations is shown both by how the mother googled for info about the beetle, and how they looked for and interacted with the sculptures after having heard the stories. They also clearly connected the animals in the stories with the physical appearance of the animal sculptures, despite the fact that the stories did not come with any visual material.

6 Discussion

From a functionality perspective; the installation has been up and running for three years at the time of writing, and data logs show that it has been functioning and used almost every day. From an interaction design perspective, which is the focus in the paper; the observations clearly show that it is possible for the target group, children and their families, to use the installation and listen to the stories. The observations show that the users can use the installation without instructions, although with some confusion at times, and that some users can stay for rather long (for the target group) to listen to the stories. We also see signs of recurring use, and that the children show signs of understanding the stories, and engaging with the content for instance though play. Getting a good working interactivity has proved very tricky. Also, the storytelling format of audio stories makes more advanced malleability difficult, since it requires lots of resources to create new content. Some users seem to have a hard time focusing on the stories. The experience tentatively seems to work better for families than for unaccompanied groups of children. Below some key findings are discussed in more detail.

6.1 Design for Nature Storytelling Experiences

The study tentatively shows that the installation can contribute to learning about nature, ecosystems, species and how they relate to each other, shown for instance by the children's and adults' comments in observation 1, 3 and 4, although not engaging everyone. There is also evidence in the observations that the stories and the installations create emotional engagement and makes children and their families reflect and relate to the content of the stories. The combination of play and storytelling shows to be fruitful for learning and to create an engaging experience, something that was also found in the literature presented in the background.

To expand beyond the isolated installation and adding additional content, such as the sculptures, flower climbing equipment and the overall impression of the playground, seems to tentatively strengthen the experience of the stories. This is in line with previous research on how playgrounds can create understanding and engagement in relation to nature [31, 83, 93]. This also goes for the nature integration, that stories are told in the narratively diegetic environment, with trees, bushes and stones. This becomes similar to the type of situated nature storytelling described by Blizard and Schuster. [20].

The form of stories seems to help create *sympathetic engagement* where the listeners care for the animals in the story, something that is apparent in how the children in both observation 1 and 2 talk about the animals in a friendly and enthusiastic tone. Using high quality narrated screenless storytelling seems to get the children's attention, without shielding them from the nature and play experience, as might have been the case with screens. This also relates to previous research on the immersive and emotionally engaging qualities of audio storytelling [18, 19, 56]. We can see that several children want to hear the stories recurrently, to an extent that the adults want to find ways to turn the hut off, in order to be able to leave, as described in observation 2. This can be seen as a sign of engagement, something that it is possible to design for [110].

The installation seems to invite to *extended use*, where several children were seen sitting and listening for quite a long time (especially for being an outdoor playground). This gives the opportunity to mediate large amounts of information. However, as can be seen in the answers to some questions, this seems to be dependent on good storytelling, with both good narratives and interesting voices. On the other hand, the direct interactivity of being able to affect the story seems to be of less importance, and the users seemed happy with mostly following a linear story. Long storylines, without much interactivity, that we thought beforehand might be problematic, seems instead to be appreciated. A more linear narrative design seems to work just as well, or even better, than an interactive non-linear format, maybe because of the dichotomy between storytelling and interactivity [1].

6.2 Design for Story-Informed Play

The form of interaction in the hut can be seen as rather passive, resulting in non-physical play [54], what is in observation 1 referred to as *calm play*, where the playfulness mainly occurs as internal fantasy, sometimes shared through discussion with the other listeners. Also, the hut in itself, both when with activated stories and in itself, seems to provide a good shelter for taking a pause or relaxing a bit, but the Hut is also used for physical play, such as climbing through the hole or banging on the stumps. However, we did not see any children pretending to be birds in relation to the hut, this was a bit surprising, since it is both embodied as a birdhouse, as well as there being birds mentioned in the stories.

We see examples in observation 1 and 4 how children in their fantasy are returning to the stories, through their play. As described in the background, especially sound and audio narratives can be forceful to create immersion and engagement, and the way the kids reenact the stories in their play can be a sign of this effect. Using the audio narratives as inspiration to create and recreate stories, turning them into a more interactive storytelling format, the children is in a way creating their own interactive fiction. This play behaviors as seen in the observations are clearly inspired directly by the stories, as specific story characters such as the fox and the bumblebee are included in the play, and would not occur in this specific way without the input from the stories. The play behaviors include several aspects of the Hughes's taxonomy of play [54], as described in the background, for instance imaginative, dramatic, sociodramatic and fantasy play combined with physical play, resulting in a *Story-Informed Play* that has the potential to both increase play values as well as cater for learning opportunities by utilizing technology to provide integrated storytelling at playgrounds and similar venues; combining the several of the positive effects of play and storytelling as described in the background.

This engagement is stronger in the children, but also visible in the grown-ups. In this way, the hut fosters interpersonal play between generations. From a play perspective, we can see that it seems important to not only look at the hut as an isolated installation, but look at how it is situated, as story related play occurs in other parts of the playground, but also at home, between the visits, as shown in observation 1. The Story Hut seems to create engagement and playful learning, this without the need of gamification elements such as points, scores and leaderboards. Rather it utilizes Playification [10, 71], building on intrinsic motivation where playfulness, curiosity and storytelling become the motors for engagement and learning. The concept ties in to preexisting knowledge on the positive relation between play and learning [88, 95, 106].

We could see several examples of what we suggest to call *Story-Informed Play*, where stories are recreated and experimented with, similar to what for instance Opie and Willett have observed where children recreate and use media references in their play [82, 107]. Designing for Story-informed Play builds on utilizing and encouraging this behavior, by offering stories on-site in direct relation to the play, thus providing interesting play inspiration, and nudging the play in a certain direction. This is one of the main ways the hut tries to be a learning opportunity, and it is further fostered in how the rest of the playground incorporates elements from the stories. This makes it possible to keep playing, and reflecting about what happens in nature near the hut, thus tying into playful, experiential [64] and informal learning [93].

6.3 Family Oriented Interactions

An interesting, and a bit surprising reflection is that all the long-term engagement interactions with the hut involved not just children, but always (as far as we could see) children and adults together. This might indicate that it is easier for the children to engage in the stories when accompanied by an adult, or it can be because the installation experience is well suited for families. It was even clear, as in observation 1, that they planned ahead for a common excursion to listen to the stories, bringing biscuits and hot beverages.

We see multi-user interactions in every observation, but for the children not typically with peers, but together with an adult. Both observation 1 and 4 also include descriptions of play sessions inspired by the stories, where both child and adults play together. We can also see in those observations how the adults scaffold learning by using their own phones or computers to look up additional information about the animals in the story, pointing towards a shared experience and engagement between children and adults.

6.4 Interactivity and Malleability

The interactivity has proven problematic. This problem, the dichotomy between storytelling following a clear narrative and interactivity, splitting up such narratives, has been previously described [1].

The later scenarios implemented contained less interactivity, and tentatively seems to be easier for users to listen to the stories. The choice making system in the stories did not work very well, as users struggled with how to make the choices, it seemed serendipitous, as can be seen for instance from observation 4. But at the same time observation 3 indicates that exploring new stories and the curiosity of what story there will be today, can be appreciated by users.

Another study on the same playground shows that malleability is much harder for the Story Hut than for the Interactive Eggs on the playground [9]. Tentatively this might be connected to the fact that writing, narrating and recording audio snippets, especially with high quality, requires much more resources than adding a new light effect for instance. Also, there are some restrictions in the system for how to add new snippets. Using audio and lending for instance recording possibilities directly to the children at the playground was discarded as an idea due to risks of people recording and mediating for instance sexist or racist messages, or other problematic content.

6.5 Recurring Use and the Unique Opportunity Effect

Although the interactivity proved difficult to utilize in a good way, the changeability in itself seems to have a value. The daily changes, not knowing what new stories they might find each day evoked curiosity and anticipation, as can be seen in observation 3. The seasonal change was harder to see if they were beneficial, this would require more studies.

R*ecurring use* seems to be common, with users returning several times, and sometimes even several days in a row, as can be seen in observation 1 and 3. The recurring use might be promoted by the daily changes, but children also like repetition [60], so it is hard to say whether the changeability in itself is the cause for the children's want to revisit the experience.

The stories were uniquely developed and narrated for the playground. They cannot be heard, streamed or downloaded anywhere else. They are also developed with the hut in mind. This, in combination with daily and seasonal changeability, provides possibilities for what we propose to call a *Unique Opportunity Effect*. We suggest that it is possible, and tentatively strengthens experiences, to design for the Unique Opportunity Effect, when designing technology augmented play installations. This becomes a way of utilizing novelty effects [37], without constantly having to provide totally new installations, instead, through the digital layer, provide change. Recurring experiences, but that are only provided during a certain timeframe at the playground, become neo-novel, they feel precious, a bit like how we anticipate a holiday such as Christmas. The Unique opportunity effect might also be enhanced if the experience is innovative and not common in other places, as the father in observation 2 points out with a very positive emphasis, that they had never seen anything like this. Thus, we suggest that temporal, innovational and locational uniqueness, in combination with the creation of a unique story through your interactive choices all can combine to a stronger Unique Opportunity Effect. This unique opportunity effect could be interesting to explore further as a design feature.

7 Conclusion

This study focuses on how to design a hybrid playground installation that utilized storytelling to create engagement in relation to local wildlife and ecosystems. Within the study a permanent playground installation was developed and evaluated, and was found to create engagement through storytelling, and also to inspire play and reflections based on the story content. It was found fruitful to utilize audio storytelling, and to integrate and situate the installation in the natural environment, as well as extend the experience through contextualizing it in relation to the surroundings and the rest of the playground. Although changeability and malleability provided additional values, the on-site interactivity of the stories turned out to create confusion and tentatively problematic in that the interactivity took focus away from the story content. We suggest two strong concepts; designing for Story-Informed Play - to utilize the storytelling as a stepping stone to encourage children to readapt the story content in their play, and to design for the Unique Opportunity Effect - that it is tentatively possible to encourage recurring use and to create engagement by utilizing different means to design for making the experience feel unique. Other design implications suggested in the study include to design for; qualitative story content, robustness, playification, screen-free interaction, ambiguity, intuitive use, multi-user, and to extend the experience beyond the installation.

7.1 Limitations and Future Research

This paper is a qualitative Research-through-Design paper, focusing on one specific installation, at a specific location, with a certain method. Other design solutions, other locations and other methods, such as more quantitative usage logging, could provide additional insights. Also concepts such as story-informed play, playification and the unique opportunity effect could be interesting to research further.

This paper focuses on children, playgrounds and nature storytelling. It could be interesting to look at how design concepts and similar installations would work in other settings, with other target groups and for other topics. For instance, settings such as museums, schoolyards, natural preservation centers and parks, target groups such as elderly or teenagers, and topics such as cultural heritage or cities infrastructure. The relation between the embodied installation, the digital layers, stories and physical surroundings could also be researched further.

The installation in focus for this study can be tweaked, and it would be interesting to do follow-up research on the installation, for instance by making new scenarios. A challenge to investigate further, that no good solution was found for within the scope of this paper, was how to balance between interactivity and immersion into the stories. Also, it could be interesting to utilize and research on the functionality of remotely interconnecting several installations, making them affect each other.

This study presents a design of a hybrid playground installation that utilized storytelling to create engagement in relation to local wildlife and ecosystems, and suggests concepts and design implications for this. Thus, contributing with knowledge on this topic and also opening for future research opportunities.

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