Growing Up in a Complex World

Engaging Children in Socio-Cultural Matters Through Speculative Installations

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ABSTRACT

The interaction design community has a long history of design and research for and with children, including designing installations for public spaces. This paper explores children's engagement in socio-cultural issues through speculative installations exhibited in a cultural institution. Over the past ten years, we explored the boundaries between technology, play, learning, and mastery through more than forty interaction design student projects collaborating with various cultural institutions. Although only a portion of projects focused on time-relevant socio-cultural issues such as pollution, refugee crises, or climate change, they opened for reflections on possible ways of including children in dialogues concerning contemporary challenges. The paper contributes a framework for designing and analyzing speculative installations for children based on the 'darkness scale' (reflecting the seriousness and complexity of the context), *scaffolding engagement*, age-appropriate *speculative pointers*, and *linking the present with a desirable future*. We showcase two installations and use the framework to discuss them.

CCS CONCEPTS

• **Human-centered computing** → Human computer interaction (HCI); HCI theory, concepts and models.

KEYWORDS

Speculative design, children, public installations, socio-cultural engagement, critical thinking and children

1 INTRODUCTION

There is little doubt that today's socio-cultural issues are becoming increasingly complex, calling for changes to the understanding of design as a discipline, including interaction design, and increasingly advocating radical and intentional changes toward the future, e.g., [7, 9, 11, 37, 53, 56]. Many designers and design researchers, such as Dunne and Raby, Auger, and Irwin [4, 23, 36] have addressed the

importance of making connections between *what is* and *possible alternate futures*. In Hertzian Tales [22], Dunne argues that design needs not only to visualize a better world but also to focus explicitly on showing links between the portrayed reality of an alternate future and the current everyday reality in which portrayed issues are encountered. These links can help people to envision and experience the kind of future they want – or do not want. Visualizing a better world, a world that is desirable, might not be simple, but choosing the future we want, according to Maturana, is essential: *"I think that the question that we human beings must face is that of what do we want to happen to us, not a question of knowledge or progress"* [47]. Re-positioning matters, through reflection and critical thinking, is one way for us to question what we want. However, as Morton suggests, thinking may have become a part of the problem: *"One of the things that modern society has damaged, along with ecosystems and species and the global climate, is thinking"* [50]. If the ability to think critically is lacking, perhaps the processes of design and making might facilitate re-positioning of the future in a different way, through artefacts that allow for sensing and experiencing and, thus, provoking critical reflection as a result [23].

Recently, interaction design and human-computer interaction (HCI) have established stronger links between research and design practices through Research through Design (RtD) [6, 24, 25, 65], where critical design practice has been one of the focal points, e.g., [4, 5, 23, 34, 49]. Increasingly intertwined with such critical design practices are experiential futures [12], design fiction [10, 44, 49], design futures and futurescapes [45], and speculative design [4, 23, 48], all allowing for articulation of alternate futures and diverse experiences and perspectives around those futures. These design approaches facilitate a better understanding of how pathways to the future are established in the present and advocate open debates around alternate futures through material objects and installations, often in public cultural spaces.

In this paper, we propose speculative installations at public events for families as a mode also to engage children in discussions and reflections on current socio-cultural issues. Adolescents and young adults are already a major driving force towards a more sustainable future, e.g., Greta Thunberg, who became an inspiration for youth worldwide to stand against further negative influences of humankind on the climate [57]. However, despite increased youth engagement, there are few efforts within the interaction design for children community to engage younger children in reflection and critical thinking through speculative design [35]. Iivari and Kuutti (ibid.) reviewed different forms of critical research and children. They consider speculative design as a form of design avant-garde and position it as an opportunity for interaction design with children but do not point to examples of work featuring speculative or critical designs for and with children.

One possible reason for hesitation among design researchers to engage in speculative and critical work with children could be the perception that it is not possible to involve young children in critical thinking as, according to their developmental stages, children gain the ability to analyze rigorously from around the age of nine [46]. If critical thinking is understood as the ability to make judgments based on the analysis of the available information and reflections from one's own cognitive processes, it is clear that critical thinking skills increase with age and available knowledge. Still, various researchers have pointed out that some form of critical thinking might be present as early as the age of three [40, 41]. While there is no established age when children are able to engage in more complex forms of thinking, teaching children to recognize cause and effect, values, truth, alternative choices, and other pre-cursors to critical thinking at a young age is desirable. Young children may, in fact, be well-suited for engagement in speculative thinking due to their cognitive ability for imaginative and pretend play from an early age [54]. However, complex topics could require more extensive guidance and support for children to be able to engage and develop their critical thinking skills.

On the other hand, it is natural for parents to strive to protect their young children and avoid discussing potentially unpleasant futures. Whenever possible, most parents naturally strive to create safe environments for their children. Overprotecting children, however, could contribute to their forming habits and attitudes that make their future behavior adjustments more difficult. For example, Ungar [62] advocates opening up safe opportunities for children and youth to experience manageable amounts of risk and responsibility. Since we are witnessing an increase in screen time among children, e.g., [61], and a decrease in the ability to think [50], perhaps it is suitable to provide opportunities to include children in some form of critical thinking around current global challenges – often not pleasant topics – as early and safely as possible.

The work presented in this paper is based on a long-term collaboration between university students from interaction design courses at bachelor and post-graduate levels and diverse cultural institutions, leading to a portfolio of more than forty interaction design projects over the past decade. Stretching even further back is the collaboration with a children's museum, Oslo Barnemuseum, first in the context of participatory design with children [15], and for the last decade, using a variety of approaches to address current socio-cultural challenges. The latter collaboration offered a context for select projects to be exhibited at weekend-long events, CityKids, arranged by the museum and described in this paper.

Vastly different from traditional museums, children's museums are inspired by the pedagogical work of researchers and educators such as Dewey, Piaget, and Oppenheimer [14, 20, 54] and aim to create different, playful and engaging learning environments. Keeping in mind the mission of children's museums, interaction design student projects explored the boundaries between interactions with technology, play, learning, and mastery.

With the trust that children's wellbeing is always taken care of and prioritized in all projects, collaborative explorations of more complex themes and age-appropriate forms of critical thinking became possible. We believe such orientation also fits with the social and cultural role of children's museums but is presently underused in the cultural offering. Although more complex themes

were represented by less than a quarter of all the projects, and only five of those became installations at children's museum events, all of the serious-minded projects jointly informed our work on developing the framework presented in this paper. We used research through design as a methodological approach to inquire into the opportunities for such projects to gain broader audiences and ways to provide positive experiences with speculative installations that include children.

This paper contributes a framework for designing and evaluating experiences with speculative installations for children based on the *'darkness scale'*, which reflects the seriousness and complexity of a chosen topic; *scaffolding engagement*, involving parents or other forms of facilitation such as narrators that describe scenarios or things that encourage imagination; age-appropriate *speculative pointers*, such as 'what if' questions related to the theme; and *linking the present with a desirable future*. Furthermore, we showcase two installations, *Emigrate to Axzaylia?* and *Noise*, and use the framework to discuss them. The first installation used a future scenario in which families needed to relocate to a new planet and the second installation featured an urban soundscape which focused on noise pollution. Both were exhibited multiple times from 2017 to 2020 at events drawing approximately a thousand visitors per event (prior to the pandemic). The installations were announced within the culture house using posters, online through the children museum's social media, and at the door of the room designated for the installation, see Figure 1. The proposed framework was then used to discuss how installations engaged families with children in more complex conversations and in scaffolding some form of critical thinking with children.

The next section provides background on speculative design and its opportunities for children, followed by the section describing our methodological approach and how the framework was established. Subsequently, two speculative installations for family-based events are described and discussed using the suggested framework.

2 SPECULATIVE DESIGN FOR CHILDREN

Research through design involves both design and research, where research is to be differentiated from traditional scientific research. As Gaver points out, science and design use different and largely incommensurable forms of accountability: *"Science is defined by epistemological accountability, in which the essential requirement is to be able to explain and defend the basis of one's claimed knowledge. Design, in contrast, works with aesthetic accountability, where 'aesthetic' refers to how satisfactory the composition of multiple design features is (as opposed to how 'beautiful' it might be). The requirement here is to be able to explain and defend - or, more typically, to demonstrate - that one's design works"* [26].

Reflective practices [59] are foundational to gaining new knowledge through aesthetic accountability, design methods, tools and processes, created outcomes, and what is mediated. Zimmerman and Forlizzi [65] describe the evolution of research through design and frame the three major directions that the design research practice takes as the Lab (combining design with experimental evaluations), the Field (utilizing participatory and user-centered design and focusing on explorations in the field) and the Showroom (engaging in speculative and critical design practices aiming to
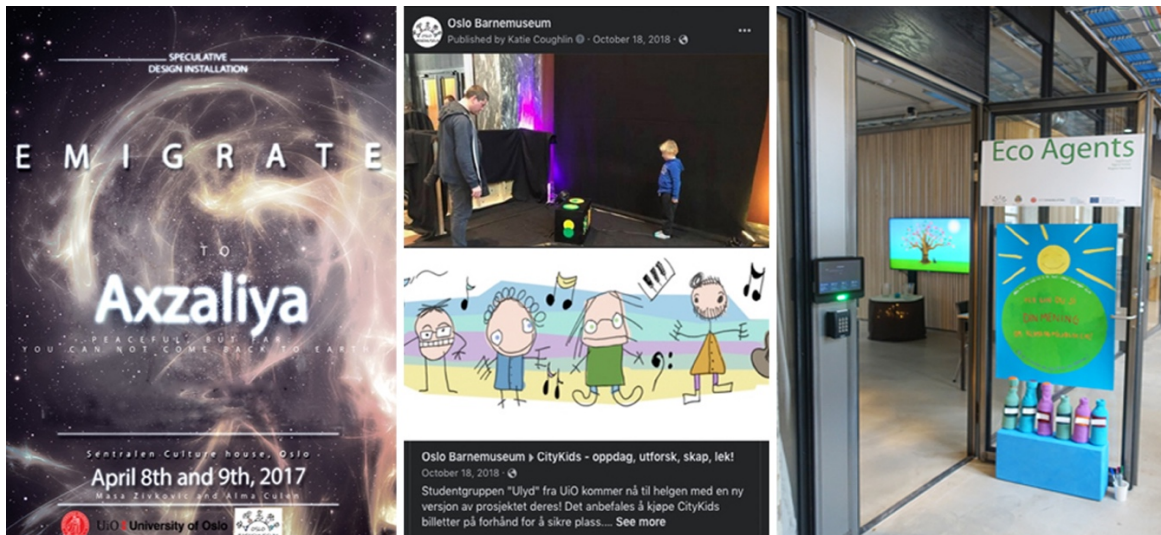
Figure 1: a) A poster announcing the CityKids installation *Emigrate to Axzaliya?* at the culture house; b) Oslo Barnemuseum's social media announcing the *Noise* installation, and c) the door signage for the *Eco Agents* installation (photo: Culén).

challenge the present and suggest alternatives). The speculative installation designs described in this paper were the outcomes of the Showroom approach. Dunne points out that there *"is a danger that if design is not oriented to the marketplace it is seen as invalid, irrelevant, or self-indulgent, especially if displayed in a gallery. But what if the gallery were viewed as a test-site for designs unlikely to enter everyday life?"* [22]. Dunne further positions artefact-centered critique and speculations as a valid form of inquiry into alternatives. Such designs might highlight alternate (at the present time), probable, possible, or desired futures [63].

As mentioned earlier, while design of interactive installations for and with children is not new [1, 3, 13, 15, 33, 55], it is rare for installations designed for children to cover socio-cultural themes from a critical perspective. This is true, despite that some forms of criticality have found various expressions in the interaction design for and with children community. For example, value-based design has been important in relation to children and has been used to mitigate various forms of divides (by ability, gender, and other), to suggest games based on cultural forms as a way to foster social changes, and to understand children's involvement with household energy, see [8, 21, 31, 32] for some examples among many.

Furthermore, the field of early childhood education also discusses issues related to sustainability and ways to create awareness and changes in young children's behavior in support of more sustainable living, e.g., [18, 19, 29, 43] or addressing a sense of personal and social responsibility [30, 39, 52].

Further, speculative design for children has been discussed [35, 64], finding – as we do – that speculative design, along with design fiction, experiential futures, and other similar design approaches, offers opportunities to even very young children to engage in some form of critical and speculative thinking. Although she does not explicitly endorse speculative fabulations for children, Haraway [28] discusses worlds filled with creatures that help

inquire into inter-species care, parenting, and queerness. Such fabulations, too, could serve as bases for developing children's critical thinking in the context of social sustainability. In summary, such interactive installations offer an opportunity to explore how children can understand and tackle broader social and planetary challenges concerning the real world we all inhabit together.

3 THE APPROACH AND THE FRAMEWORK

Considering the aesthetic accountability and the idea that research needs to demonstrate that designs, in this case speculative installations, work for the intended purpose was the initial aim with developing the framework. As a growing number of student teams expressed interest in working with children and global challenges, we needed a basis to scaffold such work. Since all projects were tested in the wild, often at various stages of the design process, we gained many opportunities to observe and reflect on interactions and experiences that both initial and later stages of design processes elicited. The families, or children, that participated in these prototyping sessions were always clearly informed that they were participating in unfinished, explorative design work and that their participation was voluntary.

Due to the complexity of topics that inspired the work on installations (climate change, environmental degradation, loss of biodiversity, sustainability, greenhouse effect, urban noise pollution, and refuge crises), we were particularly observant of ways in which children could relate to the theme, emergent interactions between children and parents or guardians, and interactions with other children when talking about alternative futures and opportunities for making a difference. We used research through design, the Field approach [65], and annotated portfolios [16, 27] to reflect on the installations individually and collectively.

We came to understand the aesthetics of designed prototypes as co-constituted by interactions with the technology, interactions
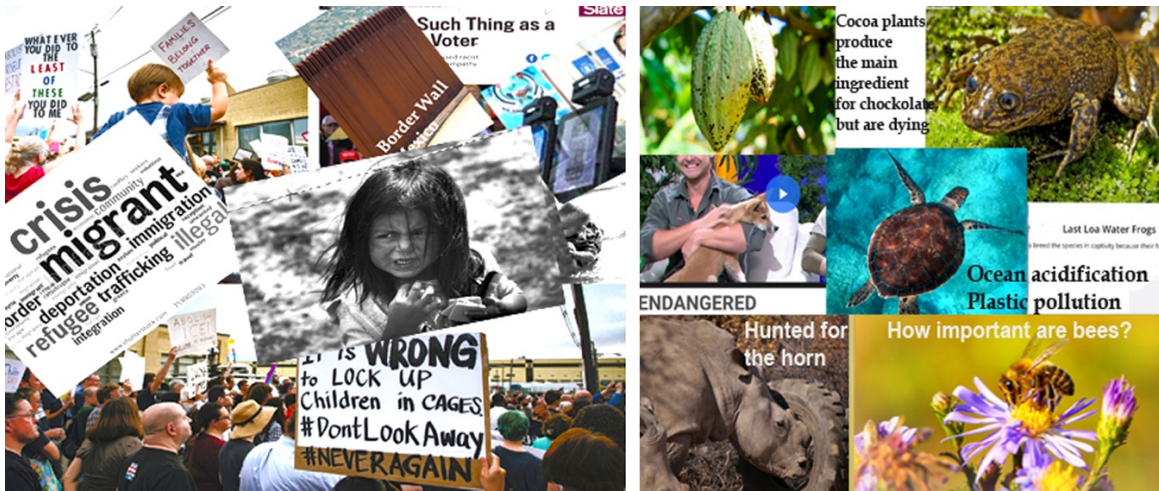
Figure 2: Moodboards help assess the 'mood' of ideas for speculative design for children: a) the moodboard considering a refugee crisis and b) the moodboard dealing with the loss of biodiversity. The moodboards usually contain images from news outlets, but these were composed by authors with free photos from Unsplash (https://unsplash.com).

with others (children or adults), and nuances in thinking and behaviors. While the technological components of the installation needed to be designed well and work well, a large part of creating satisfying aesthetics consisted of negotiation of the mood associated with the treatment of the topic. A particularly relevant aspect of this became the level of 'darkness' of the mood that is appropriate for children to ensure that the installation worked within the margins of manageable risks [62].

The tool that we suggested to student teams who focused on more serious topics was moodboarding – making a collage of newspaper articles, videos, and images related to the design context and showing the mood that the design might convey. In the initial phase of design, when the context for design needed to be understood and situated in the context of cultural offerings for children, reflections on moodboards helped to assess the appropriateness of themes and moods considered. For example, the mood that Figure 2 a) conveys is 'darker' than the mood elicited by the moodboard shown in Figure 2 b), where the video shows smiling hosts engaging with endangered animals and images featuring beautiful photos of endangered species. Moreover, for children, saving animals is meaningful, positive, and easier to understand in terms of causality than is reasoning behind migration and visible suffering that is often a part of refugee experiences. Thus, the moodboards could provide the first understandings concerning the mood that an installation might communicate.

The discussions concerning moodboards inspired wider use of the concept of *darkness* and a scale to indicate the serious-mindedness of the topic and its possible expressions. The scale works on a continuum between light and dark. A dark mood, such as the one in Figure 2 a), does not imply that children should not be exposed to conversations around such themes. It does, however, imply that more care might be needed [58] toward creating meaningful reflections and managing potential risk situations [62].

Additional responsibility rests with design teams when addressing such complex topics with children through speculative installations. Careful ethical considerations, judgments, and decisions need to be made on the scaffolding of children's engagement – primarily for the sake of children, but also in terms of research responsibility and the host institution's social responsibility. Furthermore, engagement with challenging topics also benefits design teams to understand why responsible research and design [2, 51, 60] are necessary, specifically in making sure designs and activities in the context of the public space do no harm but instead steer in socially desirable directions.

As researchers, we observed the projects being tested in the wild. This included taking field notes and photo documentation (of activities rather than visitors), still with oral consent of those present. We used the photo images related to each event to produce a collage similar to moodboards, showing activities from events, see Figure 3. We then annotated these images as a way of reflecting 'on action' [59]. The annotations helped us map various concerns regarding scaffolding children's thinking and ways of engagement with the installation. Annotations such as 'light' or 'fun' indicated experiences with the installation. 'Highly collaborative' or 'self-exploration' indicated how children reflected best during the activity. Annotations like 'drawing' or 'LittleBits' were concerned with materials and objects that supported the activities. Some annotations dealt with the use of the built space, such as 'youngest children zone', indicating that the youngest children might need a separate area for their activities. Any concepts that could trigger critical reflections, e.g., point the conversation in a new direction or highlight several different perspectives, were included as 'what if' prompts, and eventually labeled 'speculative pointers'. Annotated boards were helpful to reflect on experiences and elicit the components of the framework. The same technique was used to map the museum's activities, where annotations showed values and principles that the museum adheres to, such as participation, collaboration, creativity,

Figure 3: Annotated CityKids events a) *Eco Agents* **and b)** *LittleBits.* **Field notes from events helped to reflect on action and annotate the images to consider them in conjunction with other speculative installations and museum's offerings.**

exploration, discovery, mastery, shared experiences, opportunities to innovate, relevance, and more. These boards were useful to reflect on ways in which an installation 'fits' with the museum's values and offerings.

The projects dealing with socio-cultural themes and in collaboration with the children's museum, are shown in Table 1. As mentioned in the introduction, not all projects got to be a part of the museum's CityKids events.

The projects in rows 1-3 of Table 1 were among the first projects exploring issues that are seldomly addressed with children. The *CityCrafter*'s team converted a large tabletop into a surface featuring tangible interactions with representations of buildings, windmills, shops, and like – all of which could be lit up so that children could explore energy use during the day and night. The *Games for Civic Engagement* team explored the opportunities that games can offer toward increased engagement in civic matters. One of the games we liked best was based on the idea of taking care of your own politician, named Tamagochi politician. The *Si ;D* project explored topics of interest for children and youth and aimed to provide easier access to debate platforms. This project was done in an extended collaboration with the largest daily debate publication for the youth of Norway. The *Climate your Way* team explored what children knew about climate change and its consequences around the globe. It used physical items and a quiz on a mobile phone to challenge children. These projects provided valuable insights, as discussed later.

The five projects developed further outside the teaching context and exhibited at CityKids events are in the last five rows of Table 1. These became installations aiming to explore the opportunities that speculative design for children in public spaces. The first such installation was *Eco Agents*. The full student team participated in creating the installation and also co-authored a publication resulting from these efforts [17]. The installation explored children's engagement in conversations around sustainability and environmental issues and featured an extended partnership with a local children's environmental organization. The *Inspiration* installation displayed what

visitors shared as inspiring in real-time and was quite engaging both for parents and children. It often led to interesting and nontrivial conversations on values that included others present in the room. The *LittleBits*[1] project was slightly different in that it was set up by two doctoral students to explore aspects of creativity with technology in the setting of a cultural institution. We ordered several professional kits containing digital, magnetically connectable components to explore the ways that families would engage in digital creativity in such settings. The children were working side by side with parents, peers, and facilitators. The collaborative engagement was so appealing that the children's museum continued to offer the activity for a long while after the research was over. The *Noise* and *Emigrate to Axzaylia?* are described in the next section.

Our research method at CityKids events was limited to passive observations of installation activities or active participation in activities as facilitators. In contrast to student projects and observations during the design and evaluation of prototypes, we did not collect any data from visitors during CityKids events, for which we would need to use consent forms. There were no photos taken (with only a few exceptions when we took photos of activities, with oral consent of those present) or note-taking. The only exception was the *Eco Agents* installation, as described in [17]. Instead, we tried to assess the aesthetic accountability immediately after the events: did the technology work as intended, could the children engage with the topic, was the level of narrative or interaction appropriate for them, could they reason, could they collaborate? These reflections were recorded and used later, with other material, to reflect on the installations.

4 DESIGNING SPECULATIVE INSTALLATIONS – TWO EXAMPLES

We now describe the two installations, *Emigrate to Axzaylia?* and *Noise*, which we observed and engaged with at family events organized by the children's museum for the purpose of exploring the

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[1]Please see https://sphero.com/ for more information on the kits.

Table 1: The projects shown in the table were dealing with topics that are not commonly addressed with children and that were the basis for deriving the framework described in this paper. Photos are from the CityKids events taken by Culén and Coughlin.

Projects	Issues considered	Interaction
CityCrafter	How much energy do cities use?	Tangible interaction where a tabletop was turned into a city map to place diverse elements on it, such as houses, windmills, shops, and stadiums. Power to each element could be turned on or off to adjust and measure the combined impact on energy use.
Games for Civic Engagement	Can games inspire civic activation?	A variety of simple games were prototyped like Tamagotchi politician, where the child/youth could create and care for a politician, learning what politicians need to live well.
Si ;D	What issues could engage you in a public debate, and how?	The project explored ways to stimulate engagement and identify issues young audiences find most interesting to discuss publicly.
Climate your Way	What do you know about climate change?	Learning about climate change using physical objects and a quiz, e.g., the children used a globe to select a country and be quizzed to answer questions about climate changes that might be experienced in that country.
Eco Agents	What can you do to live a sustainable life?	The CityKids installation with multiple interaction areas: leave a voice mail for politicians, answer interactive quiz questions about sustainability, tangible interaction to play videos featuring pollution issues to discuss how to mitigate the problem.
Inspiration	What inspires / inspired you as a child?	This CityKids installation provided parents and children with an opportunity to express creatively what inspires them, display it on a large screen and open it for discussion with others in the room.
LittleBits	What can you imagine with technology?	The families at CityKids events were guided to use LittleBits creatively, asking questions like 'what if' they could imagine and make a car of the future, or an art (drawing) machine.
Emigrate to Axzaylia?	Would you live on another planet?	CityKids installation detailed in this paper.
Noise	What makes up the urban sounds you hear?	CityKids installation detailed in this paper.

opportunities that speculative installations offer to engage families in more complex conversations and support children's critical thinking.

4.1 Emigrate to Axzaylia?

At the start of each project, a broad range of possible themes was considered and discussed, and assessments were made concerning the difficulty of technological implementation and creating possible cognitive pathways into the theme for children. Furthermore, the impact of the exposure to the theme was considered (e.g., a classmate newly arrived from a war-ravaged country might be seen differently by a child after exposure to the installation concerned with refugee crises and conversations regarding it).

The student team that worked on this project decided to look into refugee crises, then into the broader issue of immigration and assimilation into a new culture. The chosen theme was then approached through moodboarding, where students created moodboards similar to the one in Figure 2 a). Even though moodboards created to discuss the theme were 'dark', the students wanted to work with the theme. It took a lot of negotiations within the team on the kind of technology and interactions they wanted and how the children could be engaged.

The team ultimately prototyped an installation that was a synthesis of several different ideas, work with moodboarding, and other explorations. They chose a scenario set in the not-so-distant future where visitors to the installation became applicants for emigration to the planet Axzaylia. The prototype was shown (and observed by the authors) at an event organized by the children's museum, and the whole development process during the course is described in the end-of-term report [66]. However, work continued on the installation after the course was over, and below is the installation description as it appeared at CityKids.

The basic premise for the futuristic scenario that the final installation featured was that pollution, loss of biodiversity, and climate

Figure 4: The main installation components: a) the instructions for the use of the DNA scanner; b) the scanner and the waiting room at the emigration center featuring a video showing the contrast between the life on Earth and on Axzaylia; c) the bottom images show the DNA scanning app, and an 'Axzaylian'. Photos: Culén.

change made it difficult to grow food in many places on Earth. This situation led to political frictions and large migrations to places where food could be grown, causing overpopulation in these places. The narratives communicating the scenario to children had different levels of detail for different ages. Nonetheless, all narratives described families facing difficulties which included air contamination (inspired by actual news from Syria and the use of chemical weapons), no food diversity (a future with no chocolate?), and a sense of being unsafe. In this future, children were no longer afraid of imaginary monsters but of the new 'normal', such as violent storms, floods, fires, and other both natural and human-caused disasters. However, families could decide to apply for permission to emigrate to Axzaylia, a beautiful, fully inhabitable planet. The application process for emigration was simple but the journey to Axzaylia was long and expensive, so people could not easily return to Earth once they had left.

The application process was fully automated and based on DNA analysis, where algorithms would determine who could leave for Axzaylia. The scenario postulates that patterns on fingertips represent an encoding of a person's DNA, see Figure 4 a). The applicant's fingertip patterns are scanned and then analysed. People with health challenges or those with undesirable genetic traits are refused. Members of the same family could, thus, have different application outcomes.

The main installation area, arranged as a waiting room at the emigration center, had a large screen showing a continuous video feed of life on Axzaylia with information about the atmosphere, surface, and dwellings on the planet. The peaceful images from Axzaylia were contrasted with more stressful news from Earth (inspired by

real news at the time). The latter contained some intense images, such as wildfires and floods.

Adjacent to the waiting room was a scanning area. The area featured a stand with a DNA scanner on a touch interface, instructions for use, and posters featuring life on Axzaylia. The stand was 3D printed and used coloured LED lights for a futuristic look, Figure 4 b).

The app developed for the installation simulated the scanning and the processing of fingertip patterns, Figure 4 c). The processing time was short, and a countdown clock was used to track the progress of the process. Results were then displayed on the screen.

Applicants approved for departure had to make another choice. They could choose to have a small chip implanted in their index finger (they needed to place the finger at a designated spot on the interface, simulating implantation). The chip would make them 'visible' to the government, but it could enable them to gain various 'capabilities' that might be useful on Axzaylia. Rejected applicants, on the other hand, could earn the opportunity to re-apply after collecting a certain number of bonus points. The points could be gathered through social work or help with environmental issues. For children, the social work and environmental improvements were designed to be age-appropriate, e.g., plant trees, share food with others, or grow food. Some seeds with instructions on planting them were provided, see Figure 5 c).

The waiting area had a facilitator (one of the authors) dressed as an inhabitant of Axzaylia, who actively helped shape the narrative. The clothing hid the facilitator´s identity and made age-appropriate narrative adjustments easier. The clothing used on Axzaylia was similar to that on Tatooine from Star Wars and suitable for the planet's desert-like environment. It was also recognizable as a burqa

Figure 5: a) Children and parents filling in application forms, watching the video, delivering drawings of things they want to take with them (left image). b) a girl watches her father use the DNA scanner before she tries. c) Rejected applicants could do good deeds, like planting seeds to make the Earth greener. Photos: Culén.

(for parents), despite its fresh, metallic silver colour and minor changes in how it was worn, e.g., the outfit was completed with thin, futuristic-looking silver 'smart' glasses.

Choices of speculative and critical cues were plentiful. For example, would you choose to move to another planet if life on Earth became difficult? How would it be if the application process allowed some family members to go, but not others? What could you choose to do to make things better on Earth? Would you work to help people in need? Would you work to make the Earth greener, even if you were approved to leave? Does it feel OK to have the chip implanted? Would it be desirable to have the chip? Could it provide cognitive enhancements (e.g., giving you the ability to speak the Axzaylian language, know its history and customs)? The children could contemplate and visually represent what they were thinking by drawing in the waiting room, Figure 5 a), and engage in dialogues with their parents or facilitators.

4.2 Noise

The *Noise* installation used speculative design to explore new auditory experiences in helping children to decompose typical urban noise into various individual sounds and to consider noise pollution, which is often unrecognized (especially by children) in urban environments. Which sounds are familiar, and which sounds are pleasant or unpleasant in different combinations? The issue of noise pollution is gaining attention for its links to serious health problems from long-term exposure to elevated noise levels. The installation also challenged the concept of a musical instrument. It enabled composition and play with an alternate instrument – a tactile box with touchpoints to sound and combine a variety of urban noises.

The work on this installation started with an inquiry into relationships children have with the production of sound. A professional musician and a music teacher supported the inquiry on how

children relate to musical instruments and sound production, allowing the project team to observe and ask questions. The design team also used a literature review to inform the design. Among the insights gained was the importance of the subjectivity of sound experiences. That is, sounds that could be experienced as a meaningless 'noise' to some could be meaningful to others. Further, the importance of exploring motivation and context for producing and interpreting sounds were found to be highly relevant. Finally, the design team spent time observing existing installations at the children's museum to better understand the situated context and what engages 'typical' visitors most. The installations at which people spent the longest time were the ones that allowed for creative use. Therefore, one design goal became to enable children to influence the sounds produced through physical action – touch – and explore the soundscape creatively.

The design process for this installation followed a more traditional, user-centered approach that unfolded through several iterative improvements, see Figure 6 and the course report [38] (in Norwegian).

The installation was designed to be intuitive in use and intended to engage children and adults who accompanied them without formal facilitation. The installation's physical form, size and placement of interactive areas, were key variables that students considered in terms of engagement. Initially, a decorated cardboard box, placed alone on a table, was used to create sounds. Sound buttons, activating different sounds were drawn on the box using electrical paint. In a single testing with users (see Figure 6 – image on the left), it was found that all key variables needed adjustments. A new prototype, still in the shape of a box, was larger and had large aluminum foil areas replacing the electrical paint buttons. Now, it could be placed directly on the floor, to which children responded well, finding it easier and more engaging. The choice of aluminum foil, however, proved to be unsuccessful. Rather than stimulating curiosity about
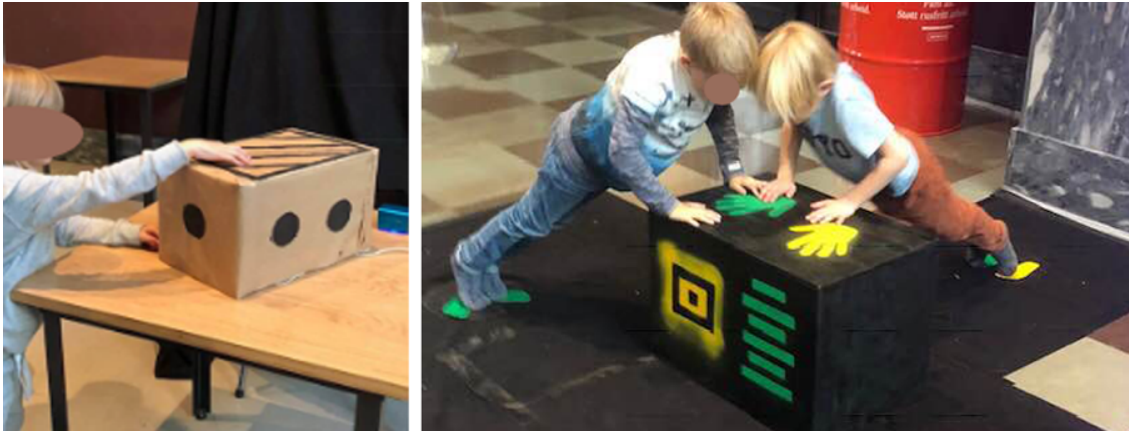
Figure 6: a) The early prototype went through several iterative improvments and increases in complexity of interactions. b) the final prototype (allowing for collaboration). Photos: Coughlin.

auditory experiences, the foil itself created noise distracting from the sounds of the box.

The final form and the speculative opportunities that the installation offered were considered in collaboration with one of the authors, after the course was finished. It was decided that the box should have more complex dimensions for sound experiences and more possibilities for speculation and exploration. A focus on composing and producing sounds from urban environments was found likely to simulate collaboration among visitors. The final installation, therefore, extended the functionality and engagement possibilities by adding remote pads, which activated different sets of sounds, depending on the contact point and on the number of people who were active at other contact points. Footprints were used on the remote pads to invite visitors to stand. Handprints were added on the top of the box to invite exploration of the touch points on the box. As it was impossible for one visitor, especially a child, to stand on the footprints and touch the handprints at the same time, the design stimulated collaboration and increased engagement. With immediate sound responses, visitors were quick to realize how different sound combinations could be made.

The final installation was found to be effective in stimulating curiosity and engaging children and parents together in composing and exploring different sound combinations, both pleasant and unpleasant. The installation now also provided intuitive clues for speculating on what sounds could be heard, whether they were pleasant or unpleasant, and could and should they be changed. However, as pointed out earlier, the conversations were not facilitated, and we relied on organic dialog, natural reactions, and discussions while interacting with the installation.

In addition to reaching the performative goal of urban noise composition in a novel way, the installation was very effective in engaging visitors generally. It also satisfied the children's museum's own interaction criteria and robustness. It was subsequently purchased for regular use along with the museum's permanent collection of installations.

5 THE FRAMEWORK, REFLECTIONS ON CRITICAL THINKING AND TRANSFORMATIVE SPACES

This section discusses what we learned and found. It is divided into four parts: 1) Considerations that shaped the framework; 2) the framework for working with speculative installations for children and how we arrived at the framework; 3) reflections on critical thinking and children; 4) towards transformative spaces for families with children.

It is important to note that the framework was still a work in progress during design processes for all projects and could not be used in its present form. Had it been ready, it would have influenced both design and activities at events. However, we could use the framework to examine how *Emigrate to Axzaylia?* and *Noise* installations supported event visitors' engagement and children's critical thinking. The framework is currently being used for the first time to frame upcoming designs for the children's museum.

5.1 Considerations that shaped the framework

The first projects, 1-3 in Table 1, were quite interesting concerning the themes explored. However, the *CityCrafter* project demonstrated the limitations of tangible interactions when addressing more complex topics – the prototype itself was limited by the number of objects and by the scope of what it might teach through interactions with those objects. While such interactions might successfully make the children understand the use of energy in the city – the more objects that are lit simultaneously, the more energy is used – they offer a narrow room for debate and speculations. Thus, the important lesson from this work was to seek more ambiguity in design along with open explorations that are better suited for dialogues and speculations. The *Games for Civic Engagement* did just that. However, that project was suitable for a bit older child, and it was designed for an individual space – a child taking care of a politician – how would they look, what would they need in terms of care, and more. The project *Si ;D* explored the public space for debates, but here too, the audiences had to be older – Instagram was used as a sharing platform, so the children had to have access

to it. The *Eco Agents* project really delivered on what the museum audiences could engage with, and it became the first CityKids event. The main insight relevant to this discussion was the importance of facilitation. The youth who served as a facilitator at that installation was from the local environmental organization, with lots of knowledge and passion for sustainability and environmental protection. The facilitator was closer in age to the children, which had a positive effect in itself. The children and their parents engaged in discussing topics from second-hand clothing to how the children go to school (transport), cleaning the ocean, or voicing their opinions and taking an active part in protecting the environment. In addition to shining a light on the subject of appropriate facilitations, this installation was successful because it offered a rich set of speculation points, implemented through separate stations in the installation. Sometimes, multiple component installations do not provide the best experiences, but this one utilized different themes and different modes of interaction to hold visitors' interest – and keep dialogues going.

The installations *Inspiration* and *LittleBits* both worked with creativity to express values and inspirations, discuss role models or construct futuristic vehicles, drawing machines, and other things requiring some visioning, skills, and willingness to collaborate. Large tables were used to sit around and work. Dialogues unfolded naturally, and visitors easily inspired each other and engaged in meaningful debates. Although fun and creative, to co-construct meaning, facilitation was also necessary. Without facilitation, these events would become just a play – still fun for the visitors but no longer the same activity. The *Noise* also had this same issue, which was partially resolved by re-design, and further improvements are still possible through better facilitation, as discussed in 5.3. As for the *Climate your Way*, it was engaging for children who could participate (they needed to be able to read and use a mobile phone). However, the activities were more oriented toward facts and learning, and did not, for example, try to draw the consequences of some facts further into the future and open up for speculation. This project inspired discussion on the last component of the framework – providing links to the future more explicitly matters.

5.2 The framework for working with speculative installations for children

As installations, *Emigrate to Axzaylia?* and *Noise* differed vastly in the kinds of emotions and experiences they triggered. This suggests flexibility and adaptability of speculative installations to a wide range of serious and complex topics where children's critical thinking can be stimulated in many ways. For example, *Noise* used interactions with the artefact itself as a dialogical tool to negotiate the meaning of noise while *Emigrate to Axzaylia?* used visual inputs and the scanner to elicit emotional and cognitive responses that could be reflected on.

Annotating *Emigrate to Axzaylia?* and *Noise*, the contrasting qualities of these installations became very apparent. Among other annotations, *Noise* was described as 'light,' 'playful,' 'self-guided,' 'intuitive,' and 'links to future implicit,' while *Emigrate to Axzaylia?* was 'dark,' 'serious,' 'in needed of facilitation,' 'complex' and 'links to future explicit.' These dichotomies helped us to take steps towards the proposed framework.

5.2.1 Darkness scale. The *darkness scale* captured the first dichotomy. We mapped all the installations we worked with on the scale and considered what different levels of darkness implied. When it comes to the installations we exhibited at events, the 'lighter' ones were more interactive and hands-on. In contrast, the 'darker' ones provided simpler interactions but engaged children in more complex matters through a rich set of speculative pointers and sometimes much scaffolding by engaging facilitators and material artifacts to outline diverse aspects of the issue and make them suitable for children. For the latter, parents were a valuable resource and guide. Emigrate to Axzaylia? and Noise were therefore also on opposite ends of the darkness scale.

5.2.2 Speculative pointers. Turning 'playful' into an activity that affords critical thinking led us to consider *speculative pointers.* Similar to the creativity with LittleBits, Figure 3 b), *Noise* was in danger of being interpreted by visitors as pure play. By increasing the complexity of the installation, the explorative and speculative aspects did come more to the forefront of the experience, even if only as bodily enactments of complex negotiations between participants concerning noise. However, as discussed later, more could be done to provoke explicit engagement in dialogues and speculations, either by re-designing the *Noise* box, or by scaffolding engagement (human, video, textual instructions, or other means of pausing the play and asking questions). With 'darker' and more complex issues like *Eco Agents'* environmental focus (Figure 3 a) or *Emigrate to Axzaylia?,* the challenge was to make a good selection of speculative pointers, in addition to affordances of the installation. For the former, one choice taken was to have the access to politicians (What would you say?), while for the latter, it was working to create better conditions on Earth (Would you work to help save the Earth by planting trees?).

5.2.3 Scaffolding engagement. Scaffolding *engagement* integrated considerations around facilitation and finding ways to support critical thinking at the appropriate level, including parents who further engaged children in thinking processes. In the case of *Emigrate to Axzaylia?,* children's engagement was achieved through dialogues, role-playing, and materials available, and in *Noise,* the engagement took place by composing and decomposing sounds through direct engagement with the installation and conversations with others. Material artefacts that scaffolded engagement with politicians in *Eco Agents* were voice-based message bottles, see Figure 1, the image on the right, or Figure 3 a), and for *Emigrate to Axzaylia?,* seeds and planting instructions scaffolded engagement. Similar to selecting speculative pointers, a range of other scaffolding choices could have been made to engage children in civic matters or to improve conditions on Earth.

5.2.4 Linking the present and desirable futures. Linking the present *and desirable futures* could be implemented through design as a feature of the installation, speculative cues, facilitators, or other artefacts in the room. For example, in the case of *Emigrate to Axzaylia?,* the DNA analysis algorithm was a link to determining a possible future for each visitor. It was then up to each person to determine if this was a desirable future or not. Likewise, with *Noise,* the sensory stimuli determined rather organically what is desirable

over time (bird songs and other soothing sounds) and what might not be pleasant at all.

Understanding possible relations between different components of the framework might be helpful when making design decisions and could contribute to design intents with installations to be met more predictably.

5.3 Reflections on speculations and critical thinking

The installations offered many opportunities for reflection on supporting critical thinking. For example, we could observe that some potential discussion directions did not arise naturally, demonstrating the need for better scaffolding also in the case of installations featuring intuitive interactions like those of *Noise*. However, even though the visitors did not verbally articulate certain connections, e.g., between noise pollution and health, their actions reflected what they thought. For example, when engagement reached a point of maximum sound activation, visitors reacted with discomfort, and the children altered their engagement with the installation to reduce the noise. They could work reflectively to decompose the noise by deactivating certain sound buttons and striving to produce a more aesthetic sound experience. The children were also very engaged in figuring out what the individual urban sounds were. One of the sounds was of birds singing, which offered a contrast to more industrial sounds, but at the same time was relatable as an urban sound. Therefore, in creating realistic urban soundscapes, pleasant sounds, such as those of birds, and unpleasant sounds, such as construction, were recognized and used by visitors for new sound productions. Furthermore, by observing the use of the installation and listening to conversations, we found that the installation could become a platform for discussing issues related to urban sustainability – with the realization that high levels of noise must be dealt with, and also by considering the presence and absence of sounds coming from the natural environment.

Emigrate to Axzaylia? offered nearly endless critical and speculative pointers but required finding appropriate articulations for children. To this end, it was beneficial to engage parents in conversations since they could best determine what is appropriate for their child. For example, several adults questioned their children about what they viewed and understood regarding videos showing the situation on Earth or the images from Axzaylia. This led to some quite interesting conversations and made it possible for the researcher to adjust the narrative to the same or a bit higher level to see if the child still understood. For example, while some children liked the idea of going to Axzaylia, others became very concerned with saving Earth from environmental threats or wanting to stop climate change. Whatever their preference, the researcher/facilitator could represent the opposing view and challenge the children to consider the reasoning behind their choice. Also, on several occasions, we noticed whole families engaged in discussion around what it means to understand others who have different customs and beliefs – likely triggered by the burqa but still adopting the Axzaylia narrative.

Questions such as trust in technology to control essential life decisions like emigration triggered many discussions with the adult visitors. Several adults asked if the DNA scanner test was 'for real' and were hesitant to use it. The scanner and chip implants

made adult visitors reflect on ways in which the present relates to the installation's dystopian future. Some visitors connected chip implantation and its traceability with machine learning and surveillance, for example, in China. Some reacted strongly to monitoring and clothing: *"I'd rather die on Earth than have a chip implanted and use a burqa"* or *"I believe that this is a possible scenario."* Some visitors related the Axzaylia scenario to the present-day immigration policies and politics, commenting on the rise of the right-wing parties and politicians.

When family members received mixed results for permission to emigrate, the children had diverse reactions. Some children repeated the test until they got the answer they wanted, while others settled on making Earth greener and happily collected their seeds with instructions for planting. On several occasions, the adults too discussed the algorithms and the unfairness of deciding based on genetic information. However, children did not participate in these conversations, which were generally too advanced for children's level of understanding. On the other hand, the children visitors were able to engage effectively in the role-play aspects of the installation and could use their imaginations to visualize a potential life on Axzaylia through drawing pictures. For children, role-play was valuable in linking the present and the future, and they responded readily to issues in the future as if they were real. In other words, role-play gave children a method to think about and engage with questions such as *"How does it feel to wait for the chip implant?"* For example, one child answered with a question: *"Will it hurt?"* and another, *"Will I then speak the Axzaylian language?"*

Visitor feedback on this installation was overall positive. However, some parents said that their children do not watch the news, as they might be disturbing, and that the video used in the installation was too realistic. Several parents also shared that they are concerned for the future but feel powerless to change it. Some thought the same for their children: *"I cannot change anything. How can my child change something?"*

Regarding the principle that interactive technologies should be developed to support speculations and conversations that help children develop critical thinking skills, we believe that the solutions presented in both installations worked well. Both installations provided a good balance between digital and analogue experiences. We found that *Noise,* with its explicit collaboration affordance, allowed the digital technology used to support interaction, communication, and joint critical reflection appropriately. With some groups of visitors, leaders emerged, such as commanding siblings or parents, who 'directed' the activities and were leading the conversations on sounds. This observation, as it was a repeating one, points in the direction of better scaffolding, where more explicit focus on speculative aspects of the installation might be interesting.

In general, the sound interactions were perceived by visitors as novel, interesting and engaging, as evidenced by observations and unsolicited positive feedback from visitors. However, certain recognizable sounds evoked more enthusiasm and use, such as birds chirping or sounds of construction. Not all sounds were easily recognizable, though, e.g. one popping sound, and it was not certain whether visitors linked the sounds specifically to urban noise, or simply regarded the resulting compositions as just noise. Having more recognizably urban sounds, such as a honking car horn which

was not included, may have helped further illustrate an urban noise setting.

Emigrate to Axzaylia? achieved much in terms of supporting critical thinking, especially with the scanner. One of the visitors told us that this was a "*Good use of technology to make us think about things such as what kind of power machines have to determine for us!*"

We can claim that both installations raised awareness of the issues they portrayed, facilitated critical thinking for children, and opened a more serious dialogical space between children and their parents or guardians. Furthermore, interactions at both installations suggest the potential for speculative installations to become transformative tools and help lead people to take a more informed and committed stance when facing real-life challenges and unknown futures. Finally, we intended these installations as an invitation for interaction design for children to explore and experiment more with speculative design approaches as a way to support the early development of out-of-the-box and critical thinking.

5.4 Towards transformative spaces for families with children

We aimed to explore the design space for speculative installations for children featuring complex topics as a program [56], where each project highlighted some aspects within this design space. What they all had in common was the idea that each supports more complex conversations or interactions between visitors, adult and children.

Experiences from events featuring the installations *Emigrate to Axzaylia?* and *Noise* suggest the potential for speculative installations exhibited in public spaces to create transformative experiences for families with children. During the children's museum events, in situ observations confirmed interest among most parents in this novel, speculative space that went beyond usual conversations and activities with children. As many have commented, the topics triggered also their emotional and cognitive responses, and led to conversations with their children from a place which felt different and transformative. In line with what was discussed in the introduction concerning the increasing complexity of real-life problems and overprotection of children [62], we acted as Law suggested "*if the world is complex and messy, then at least some of the time we're going to have to give up on simplicities*" [42]. Speculative installations provide parents and children with opportunities to give up on some of the simplicity.

Finally, it is worth mentioning that we view the work with installations as value co-creation through partnership between the children's museum and the university, where interaction and, lately, transition design students can experience meaningful learning featuring entanglements between technology, design, and the sociocultural sphere for children.

6 CONCLUSION

This paper has considered the opportunities and qualities that speculative installations with a focus on more complex social and environmental challenges offer to families with young children within public cultural spaces. As the installations were prototyped in the context of interaction design courses, the material expenses were

low, and the return on investment of extra time to finish them and exhibit at events was well worthwhile. Furthermore, a chance to exhibit the installations multiple times enabled improvements in interactive technologies used and ways of visitors' engagement. Subsequently, observations and annotations of multiple events helped us to frame the design space in terms of 1) the complexity and serious-mindedness reflected through the darkness scale, 2) scaffold engagement in critical thinking through facilitation, 3) a set of speculative pointers, and 4) links between the present and the future. Joint discussions, in particular with parents, provided possible transformational spaces, as conversations deviated from what was established in their everyday lives. Thus, the paper's main contribution is the framework for working with speculative installations for children. The two installation examples suggested methods and techniques that we found helpful for this particular design context. They are familiar methods, such as moodboarding and annotated portfolios, but used somewhat differently in this context. Finally, we noticed that children could navigate presented challenges well, and parents engaged in helping them from their own interests in the topics under discussion. This indicated a possibility for speculative installations to open a transformational space in communications between parents and their children. However, this requires more work and observations in the future. In the context of a course, we are currently exploring children's active participation in shaping installations through creative repair or re-design of toys or clothes, and how more permanent sustainable practices could be developed based on understanding some aspects of consumerism.

The designs that we described in this paper present an opportunity to become a new cultural offering for families with children that helps shape new values and practices.

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