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Special Issue on Designing the future of technology with and for children

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Introduction to the Special Issue

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This special issue is a result of two workshops with the topic of *Researchers' toolbox for the future*. This workshop series is dedicated towards exploring, discussing, redefining, and formulating methods for imagining the future of technology, one that is empowering albeit provocative. In these workshops, we build on critical and/or future-oriented methods such as critical design, speculative design, design fictions, and others. Our goal is to compile a methodological toolbox for the future of human-computer interaction research; one that enables us to inquire, design, and critically examine our technological futures. The first workshop was held as part of the International Conference on Interaction Design and Children (IDC'20) in June 2020 and the second workshop was held as part of the Nordic Conference on Human-Computer Interaction (NordiCHI'20) in October 2020. Both workshops were organized online due to the current COVID-19 pandemic. This special issue contains some of the position papers for the workshops. In these workshops, researchers and practitioners discussed, critiqued, imagined, and redefined methods and approaches towards technology design for the future. The special focus in the workshops was designing future technology with children for children. The authors of this special issue want to find ways for children to imagine their own futures, not only adults imagining the futures for children.

The papers in the special issue form an interesting combination to approach the topic. 'Future Oriented Child-Centric Character Design and Interaction in Culturally Diverse Games' by Giri discusses the need for cultural diversity and culturally meaningful interaction in game design. 'Towards a Child-Led Approach for Children's Activation' by Miccolis brings to our attention children's agency and bottom-up participation in the change-making in their community. Tuvi and Okkonen in 'Children Centered Living Lab Approach Development in Education' continue by discussing the potential of living lab approach – trying things out 'in the wild' – to bring valuable understanding for technology developers. Walia and Eden take a step further in their paper, 'Empowering Children as Co-Designers of Technology', where they take children's empowerment in focus and want to change the status of children from end-users and evaluators to co-creators, instead. Norouzi continues from this, by pondering what it can then mean, when people of different ages work together, in her paper 'Intergenerational Aspect of Digital Fabrication and Making with Children.' Finally, with Druga and Michelson's paper 'Research Toolkit for Family Speculative Play with Future Toys' we come back to where we started: meaningful game design, and how to bring value for children and families through games. The papers show that even though all these papers have had

very similar inspiration in the form of the workshop call, very different roads can lead to the same goal: best for the children.

Future Oriented Child-Centric Character Design and Interaction in Culturally Diverse Games

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Abstract

This paper discusses the need for diversity and authentic cultural representation in the design of digital characters, inclusive games, and interactive media content for children. Games and interactive media play a huge impact on children's cognitive, emotional, and social development. It is essential for designers and researchers in the child computer interaction community to build design frameworks that include children as co-creators of narratives, characters and meaningful game interactions that reflect children's everyday lives. My personal motivation and driving values in this field are to utilize high-end computer-generated production technologies to narrate culturally diverse stories and to bring well-researched child-centric critical designs into production. My work will also focus on de-constructing the interaction mechanics [1] [2] [3] and the cultural interaction loops with digital characters [4] [5] in game interaction design. I conclude the discussion in this paper explaining the need for a futuristic approach in the design of media content and technologies, by presenting a few design paradigms and futuristic methodologies.

Author Keywords

Digital Character Design; Culturally Meaningful Interaction; Child-centric Interactive Media Design; Design Fiction; Future of Technology Design

CSS Concepts

• Human-centered computing ~ Interaction Design ~ Interaction design process and methods

Introduction

Diversity and cultural representation are significant factors in the design of inclusive games and interactive media content. Less explored themes and narratives with diverse characters are helping gamers learn more about their own culture and have their unique voice heard in gaming communities. The effectiveness of incorporating cultural aspects into the game design process is far beyond replicating physical attributes and requires a certain degree of cultural authenticity in the game elements and gameplay interactions.

Further, there is a huge divide when it comes to culturally diverse entertainment content that is created for children. There is not much research done in building design theories that can deconstruct and elaborate the character interaction mechanics and cultural interaction loops in games and entertainment media. It is important to evaluate the efficacy of these culturally critical designs that play a huge impact in children's learning and understanding of their personal identities. Research frameworks that facilitate co-creation with children as cultural ambassadors and design theories that help practitioners grasp the essence of cultural aspects will help create more child-centric designs. It will also encourage children from around the world to enjoy interacting with such critically designed content. They can identify with stories and build personal bonds with memorable media characters and play games that enhance their lives beyond the game world.

Character Design Studies in CCI Literature

A review of child-centric character design and game interaction in the child-computer interaction (CCI) literature shows studies that focus on various design aspects and methodologies for co-creation with children.

A CCI research work by Carter et al. [6] used qualitative and quantitative methods to study the influence of stylistic elements of animated characters on targeted child audience of various age groups. The results show that current artistic trends do not accurately reflect the character design preferences of children. Their qualitative analysis of animated television shows for kids between the age group of 3 to 11 years, showed that animators systematically varied head size, eye size and eye roundness depending on the age of their audience. However, their experimental results show that children's preferences of virtual characters did not vary by age. When children were allowed to create their own characters, they showed a preference towards regular sized heads and wide-set eyes, which was not quite aligning with the popular design trends and assumptions about designing for child audiences.

Gray et al. [7] describe their experience designing for para-social relations between children and media characters. The key components that define a para-social or one-way emotionally tinged relationship between children and media characters are personification or a child's belief that a character has person-like qualities, social realism that the character could appear in real life and attachment or the emotional connection. In the course of Sesame Workshop's decade long experimentation, the designers have learned techniques to help children build strong relationships with characters. "Breaking the fourth wall" design technique (e.g. character turns towards audience and asks a question) helps children interact with and build empathy towards media characters. Portrayal of rich facial expressions in the context of situations familiar to children promote character affinity. Mixing interactive characters with classic playthings can promote social play and engagement among children. Procedurally generated dynamic content allows characters to realistically respond to children's actions leading to meaningful interactions.

Design Methodologies in CCI Research

Previous studies in the CCI literature also explore methodologies to design characters and meaningful interactions in games. Walsh et al. [8] use a virtual sandbox game

environment as a co design tool to leverage children's experiences in a technology pervaded world. They suggest a distributed participatory research approach in game worlds as co-design spaces to involve a larger global audience to enhance the design process. CCI studies show that computer games can also engage children in critical discussions of cultural awareness and empathy [9]. Game narrative, environment or the cultural space and the game's goals form key components for engagement [10]. Agency to make key decisions in the game design process helps children make their own choices. Supporting children in the reflection process helps them understand what and why something is important [11]. These are key design points that help build culturally meaningful interactions for children in games.

Participatory design projects have also explored child created personas that enable child designers to empathize with other children and provide diverse perspectives [12]. Personas as fictitious characters help child designers internalize other children's perspectives based on their common needs and likings. Benton et al. [13] explain that young children can comprehend narrative structures and that including children in the narrative design phase can result in games that are contextually, temporally, and culturally relevant to children's life experiences. Grundy et al. [14] propose a method for understanding the emotional needs of children through character design. Designing characters is a fun activity and characters as mediators of emotions can help investigate children's feelings towards sensitive issues.

Driving Values and Motivation

Personally as a researcher, I advocate for critical design and co-creation with children. My broad research interests are to study contemporary design practices in the computer graphics and interactive entertainment industry. My research objective is to develop design expertise through reflective practice and to design enjoyable frameworks that support entertainment professionals and studios in handling real-time production complexities. I have worked on numerous child-centric world-class animated feature films, television shows and entertainment rides before moving to doctoral research work. As a doctoral candidate studying entertainment media and design, it is important to investigate the critical aspects of entertainment design and audience reception. A couple of graduate courses in 'children and media' and 'research with (not on) children' gave me the critical lens to analyze content created for children.

One of my current studies focuses on integrating theories from different disciplines to create an interdisciplinary framework to study digital character design process in games and other computer-generated interactive platforms. Interviews with character designers from major entertainment studios highlighted the fact that character design in animated feature films and games is a highly story driven process. Designers study real-world references to design the physical attributes of the digital character. However, these character designs do not follow a standardized process (or is one required?) nor involve adequate audience feedback. I understand that the nature of commercial production does not provide the necessary resources for critical design and research. Designers lack time to critically reflect over their practice in commercial production. Academic research can fill in this gap by supporting designers with well-researched theories and conceptual design frameworks that are grounded in practice. Research methods like cultural probes

and design guidelines that are practically helpful to practitioners will help them grasp the essence of cultural aspects when designing virtual characters.

One project that I worked on for almost a year with the game design students at Indiana University Bloomington involves a ten-minute animated short film that portrays an Indian dancing doll that learns to dance 'Bharathanatyam' – an Indian dance form [15]. The short film is a proof of concept in utilizing high-end computer-generated film making technologies to narrate culturally diverse stories and bringing high quality inclusive designs to production. I hope to work further in this direction and involve children from diverse cultural backgrounds into my production process. My future research work will also focus on de-constructing the interaction mechanics and the cultural interaction loops that are currently missing in game interaction design. A detailed study of regional toys and children's interaction with these play objects can provide design insights for culturally meaningful play in animation and gaming content.

Future Orientation

Today's children live in a world of technology mediated communication and they constantly interact with media in their day to day activities. It is important for researchers in the field of child computer interaction to adopt to futuristic tools and methods. The fast pace of technological advancement gives us the power to create our own futures and opens endless possibilities. However, the nature of this advancement and its complexities question our existing approach to research work. Media practitioners and researchers can benefit when their approach to technology design and research for children takes a futuristic orientation.

Intelligent agents and artificial intelligence driven interactive characters (and social robots) can generate far deeper emotionally meaningful connections with children. Interactive character designers should consider different modalities and children's comprehension of transmedia connections when designing narratives and media characters in various media platforms. Gray et al. [7] propose strategies and questions that designers of futuristic technology bring to transmedia character development. Designers will question the level of personalization of digital character interaction. Whether a data driven approach that adapts to changing patterns in the child's behavior will drive the interaction experience? What data will inform the digital character's evolving understanding of the child.

Additional questions that I would like to add to this list are: what kind of design tools and methods empower children to create their own digital characters and interaction modalities? How culturally sensitive are the interactions with digital characters in the gameplay? What are the metrics that determine children's interaction experience in terms of behavior, attitude change, learning, general well-being, ethics, and others? How do the interaction patterns vary across environments like classroom education with peers and instructors, co-designing/playing with family and remote interaction with other children?

Advances in theories of children's cognitive, emotional, and social development are also enabling practitioners and researchers to rethink their approach to technology design for children. Antle [16] suggests interaction designers and researchers to think about new ways in which children interact with computers, that are better aligned with

children's developing abilities and construction of meaning through action. An embodied perspective to human cognition explains how children develop knowledge through spatial properties of environments, exploit physical action for dynamic offloading of cognitive processes and build abstract knowledge through metaphor. Such findings can inform better design of interfaces, interaction modalities, and media design for children.

Children in this era are digital natives who are born into a world of interactive technologies. There are reasons for researchers who are digital immigrants to make wrong assumptions about children's experiences with interactive technologies. One research direction would be for children to lead research topics on the various effects of media and interactive technologies. First-hand knowledge of the harmful effects experienced by children from playing games and interacting with digital characters can help researchers understand the problem better. Children can also provide their own solutions to overcome these issues.

Personally, I am interested in learning more about how children perceive their traditional roots to evolve their identities in a global context. Critical design, speculative design and design fiction are design paradigms that can help design content that is well-researched and has a futuristic and critical orientation towards game character design and interaction [17]. Partnering with children from various backgrounds and applying futuristic approaches can help gather rich information, that can inform designers with critical design guidelines for futuristic character and game interaction design.

1. Questioning – Asking children questions about their experiences interacting with digital characters and the design aspects that are misrepresented from their real life can reveal valuable insights. Researchers can also question children about future projections of their lives in characters, narratives, and game play. For e.g. children face emotional issues when their favorite media characters no longer exist. Inputs from children on the future destiny of these characters or even a fading cultural practice can help designers prevent emotional breakups and make children's voice heard better in designs.

2. Re-designing – Global issues can be understood from a child's perspective by presenting narratives and scenarios, asking children to re-design them. Telling a tale or situating issues in a context can help children understand difficult issues (e.g. ethical matters) and motivate them to work together with researchers in solving design problems. Narratives can include tangible cultural probes to understand what they like about their culture or what they would like to see more in their personalized digital characters. Sample designs can also be shown to children and asked to re-design. This gives them the base material to think and re-work on.

3. Re-imagining – Children are imaginative by nature and this method can help designers get child-centric solutions for problems that are hard to grasp for a reality constrained adult thinker. New modes of interaction with children and novel game mechanics can be derived from this method or even from mere observations of children re-purposing designs based on their own imaginative play. Presenting children with a utopia-dystopia model of a certain issue can encourage children to come up with their own perspectives on critical issues, that help researchers understand how they visualize their futures.

Conclusion and Future Work

To conclude, my interests in design fiction come from Alex McDowell's work in worldbuilding and futures studies [18]. The worldbuilding process fits well with several theories and approaches in futures thinking and methodologies. Creation of story worlds is a highly social, integral, and collaborative process. Integral futures provide an opportunity to look at issues from a subjective, inter subjective, objective and inter objective perspective. Characters in the story-world examine the individual's interior and exterior worlds. The story-world setting provides ways to examine social groups, cultural systems and technologies in the fictional environment that reflects the collective. My futuristic goal in child computer interaction research work is to build collective story worlds with children from diverse backgrounds (cultural, social, economic and others) to envision empowering collective futures.

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Towards a Child-Led Approach for Children's Activation

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Abstract

Nowadays, wicked problems require society to seek for long-lasting transformation by applying diffuse creative competencies. Children's abilities could flourish by practice and lead to profound social change. Nevertheless, children's involvement in practice-based innovation is still limited. The current work investigates strategies to create arenas for children's participation, without a top-down involvement from the institutions. A research through design study was conducted within a municipal social innovation project, to explore how 6 to 12 years old children can activate towards change-making in their community. In a series of participatory design interventions, a preliminary children's activation journey has been iteratively prototyped, informed by child-led dimensions and creative flow. Children's role in the journey is discussed to provide further research directions. It is concluded that the method represents a viable access point for children bottom-up participation in urban activism.

Author Keywords

Participatory Design, Children empowerment, Child-led approach, Change-makers, Activism

Introduction

For centuries children have been regarded as fragile incompetent beings in need of adult protection and guidance. In the wake of the UN Convention on the Rights of the Child, recognizing children's right to express their views on issues that concern them [1], society started considering children as "beings", with a complete set of unconventional capabilities. According

to Vaneycken [2], children are playful and constructive disorganizers of the world and competent meaning-makers. In other words, by disrupting rules and interpreting experiences in new ways, they can control new meanings, bypassing entrenched conventions, and communicate them to adults. Consequently, children could offer valuable contributions to solving wicked problems. The interest in boosting children participation, emerged in the last decades, from both the political and academic agenda, has revealed hard to convert into a day to day practice. On the one hand, while collecting themes and patterns of designing with children [3] and investigating the expansion of children protagonism in Participatory Design [4], scholars face the methodological concerns of children empowerment and emancipation. On the other hand, due to children's exclusion from formal structures of participation in democracy, the can have

a say in society in few arenas, defined by unbalance of power relationships between children and adults, who set agendas and conditions of participation on their terms. The practice-based innovation platforms, raising at a hyperlocal urban level, could represent promising opportunities for children involvement, due to their cross-boundary settings where diverse citizens can co-create real-life solutions bottom-up [5]. In social and urban contexts where public administration fails to accomplish its mission and innovation arises from grassroots citizens' initiatives, children, unlike adults, are not in the position to enter the collective spheres of urban activism. Both cases show limitations to children's participation, who are denied recognition as citizens and lack the chance to unleash their competences. Based on the above premises and given the urgency to define appropriate environments for children active citizenship, the current work focuses on exploring strategies for children participation, in the absence of top-down involvement, and elaborates upon how children can activate for change-making in their local community.

Motivation

Enabling children to claim their right of expression on social matters and their role as active agents in the solution of wicked problems means setting up a threefold continuous cycle of reciprocal and intertwining values for both children and society. First, giving underrepresented groups, like children, access to decision making supports the ongoing process of making democracy more inclusive, while nurturing children autonomy and long-lasting civic engagement. Secondly, combining children's inherent expertise with hands-on 21st-century skills can unfold unexpected innovation while fulfilling individual competence. Thirdly, playing a proactive role from young age help embracing collective transformation while increasing the relatedness with the local community. From the ladder, it is clear that the study is driven by the intention to strive for a resilient future society, by empowering children to flourish and grow to their full potential as individuals and citizens [6] (self-determinacy). This is especially relevant in marginal contexts, with at-risk children, to subvert with adults' practice of handing on their conservative mindset to children and enable children themselves to shape their destiny. Sitting at the intersection of 2 domains, the study takes and draws relevance in children culture and participation in design and participatory design for city-making. Figure 1 shows study values reciprocity across the domains and underlying motivations.

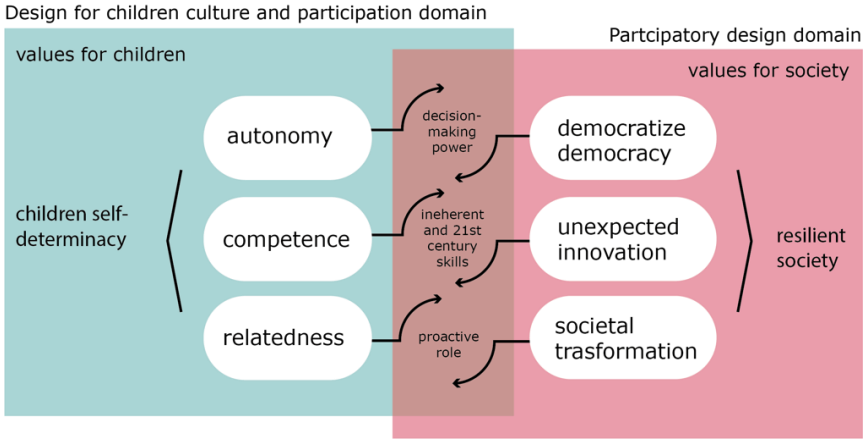

Figure 1: Study underlying motivation and values reciprocity across domains

Approach

To address the gap identified, the purpose of the current study is to define new environments for children active participation in the societal debate, within urban innovation platforms, in the absence of a top-down involvement. This translates in the challenge of designing a procedure for children's activation towards change-making. The intrinsic nature of the challenge entails a combination of interactions currently absent in children practice. Thus, a Research Through Design approach [7] (RTD) has been considered appropriate to generate knowledge by prototyping experiences, impossible to study otherwise. The peculiarity of the approach consists in shifting focus from theoretical research to empirical design across time. Therefore, the process of the current study is structured in 3 iterative cycles, respectively named after the main activities they include: Cycle 1-R, research on empowering through design; Cycle 2-RTD, unlocking change-making initiative; Cycle 3-D, designing the activation journey. An overview of the process structure is showed in Figure 2. All the phases are led by the following research question, that operationalise the concept of children's activation mentioned in the overall goal: *how can children aged 6 to 12 years old activate to identify and take action towards challenges relevant for themselves and their community?*

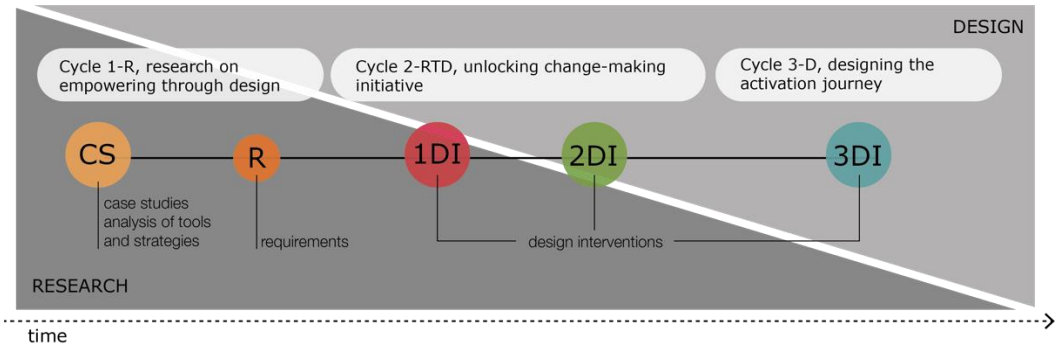

Figure 2: Overview of study approach

Specifically, Cycle 1 opens the inquiry with the case study analysis of 6 tools and strategies for children empowerment through design. Cycle 1 outcomes consist of a set of requirements for the design presented in the following paragraph.

Cycle 2 and 3 are entirely dedicated to iterative prototyping of the child-led activation journey, across 3 design interventions mainly shaped as participatory sessions. The qualitative analysis of the multifaceted data collected in Cycle 2 resulted in the visualization children's intuitive change-making flow, enriched by the enablers and gaps children seek or encounter, and the needs they expect to be fulfilled throughout the process. The final child-led activation journey elaborates upon this outcome.

Due to its format, the present paper focuses on Cycle 2 and 3 and introduces the final project outcome only. Nonetheless, the requirements resulting from Cycle 1 are presented in the following paragraph for clarity's sake. The remaining outcomes are extensively described in the author's previous work [8].

Requirements

The activation journey, object of the study, elaborates on previous work, where analysis and comparison of existing tools and settings for empowering children through design were conducted. The insights collected pointed at a lack of proper means to enhance genuine children-initiated processes of change by design. Thus, it is relevant to unlock child-led dimensions in the design of the approach. The identification of tools common patterns highlighted 3 empowering strategies, to keep as reference pillars when prototyping the activation journey:

1. build-up of I can mindset, an unconditioning phase for children to recognize their abilities, their impact, and raise intrinsic motivation to bring their contribution;
2. take action, a phase of decision making over the identification of challenges, opportunities and actions to take;
3. community involvement, an occasion for playing an active social role by sharing ideas and solutions.

Set up

The study was conducted as a dedicated laboratory within the weekly creative practice of the children centre of "Reti Civiche Urbane" (urban civic networks): a social innovation project, aimed at promoting urban and human regeneration in the fragile outskirts of a middle-sized city in the south of Italy. A total of 29 children (6-12 years old) were engaged in the laboratory that ran over 20 weeks, between March and August 2020. The choice of such a context aligns with the overall project purpose and is preferred to a school set up, where the power dynamics limits children's freedom. To iteratively prototype children's activation journey, 3 participatory sessions were organized in a blended online/offline set up. Participatory sessions enable children to develop ownership and consequently opinions on the process they are following. In line with the requirements, the interventions were designed to explore the child-led dimension by gradually disclosing different degrees of open-endedness in the activities frame and studying children's initiative within it. All interventions were designed around the empowering strategies, set as reference pillars and taking into account the digital or analogic format of the session. Therefore, different types of stimuli (showed at figure 3) were introduced in the context:

- a workshop about "children's community" entailing a series of playful activities without formal instructions facilitated by the researcher;
- a digital application about "making a change in the world", including open goal-oriented tasks and a scaffolding system to enhance children intuitive flow and autonomous decisions along the process
- a preliminary version of a tool for young changemakers translating the activation journey into activity cards, to be used in the field without expert facilitation.

The data were gathered through video recordings of the design interventions and subsequent semi-structured interviews (45 minutes in duration) with both children and supervisors, to collect their retrospective reflection and experience without interfering with the natural activities flow.

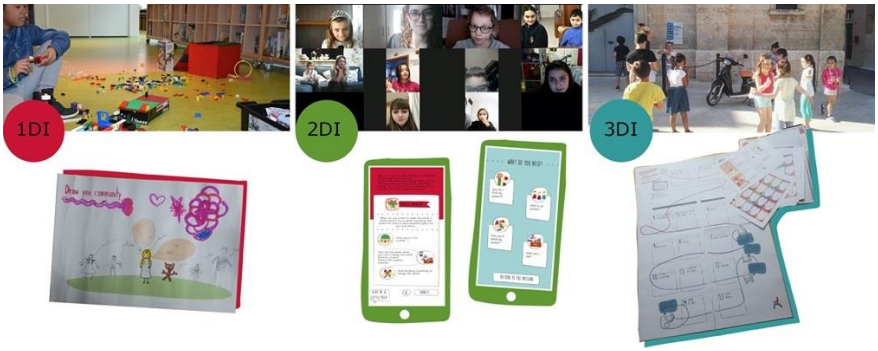

Figure 3: Overview of design interventions stimuli and set up impressions

Results

The present study started with the intention to define new environments for children active citizenship and participation in society in the absence of a top-down involvement. The insights generated embracing the challenge of activating children towards change-making in their community, informed the design of an activation journey, based on a child-led approach. Specifically, the method consists of 5 consecutive steps complying with children intuitive creative modus operandi and embedded in the frame of a "change-making" storytelling. Each step defines the goal and cluster for the series of open-ended design-based activities, it entails. The child-led activation journey encompasses the following steps and respective activities:

- raising I can mindset through reciprocal identification and materialization of children's powers;
- finding relevance in opportunities for change through a drawn peer to peer playful debate;
- becoming protagonist of opportunities through contextualization, exploration and mapping;
- powers-driven ideation and fabrication;
- training courage through building platforms for the public performance of ideas and solutions.

Besides enhancing the possibilities of expressing decision-making power over opportunities, challenges, problem and solution space of their own choice, the child-led dimension of this approach lies in several aspects. The first and the second ones, respectively shaping the steps along the lines of children's intuitive creative flow and translating them into abstract guidelines, combine to generate the open-endedness factor. This enables children to have an understanding of the process and keep in mind a purposeful goal, while freely choosing how to interact and engage with each step and activities. Thirdly, the initial co-reflection on children's abilities reinforces their decision making over the process, motivating children to play the role that shows more affinities with their natural inclination. In the fourth instance, the storytelling and the language of the overall activities frame are void of design-related technical terms. They rather consist of a narration that addresses children directly and a vocabulary familiar and understandable by children. Lastly, the alternation of making and thinking activities across the steps encourage children to craft the tools needed for orienting and progressing along the activation journey. While creating experiential and material

triggers for their own action, they nurture their making skills and strengthen trust in their initiative.

Discussion and future orientation

The 3 design interventions, including the pilot test of the presented activation journey embedded in a preliminary tool for young change-makers, showed evidence of children activation. Specific roles children play along the journey are spotted and the respective enabling techniques are discussed to open up direction for future research in the field of empowerment on children's own terms.

The peer identification of competences (powers) and their use as the main source of inspiration in the consequent solution-making (powers-driven ideation) encourage children to overcome the lack of protagonism they would encounter in their intuitive ideation, resulting in solutions of which they are only passive spectators. Evidence has shown that providing children triggering questions linking their own abilities to the specific problem space makes them reconsider their role from a passive to a protagonist one. As a result, they envision concepts and solutions, feasible with their own skills. Moreover, this technique fulfils children's need to have proof of their abilities through recognition from an external source or its practical use for a relevant purpose. The limitation observed lies in children's intrinsic mistrust in mastering their competences, which obstacle the transition from conceptual ideation to hands-on making. Further research could address this limitation by investigating practices to strengthen the rising of I can and its correlation to children's protagonist role in the ideation and fabrication phase.

Another relevant pattern observed across the three design interventions is children's spontaneous inclination to ideate futuristic concepts, aligned with the principles of speculative design. In both cycles, through intuitive or powers-driven ideation, children came up with "novel, thought proving artefacts" [9] for wicked problems they considered relevant. While doing so, children play a provocative role that could valuably contribute to their participation in critical design [9] and city-making. The speculative interventions could represent a powerful means for sending provoking messages to the adults' audience. Those considerations open up directions towards new child-led forms of activation, worth exploring. Specifically, questions arise around children's possibilities to recognize the critical value of their intervention as a carrier of a provocative stance and on the other hand, how adults would perceive it, coming from a child's perspective.

The training courage step, aligned with children's need of being heard by adults, effectively allowed children to build an analogue physical platform that echoed their ideas and views on relevant social matters locally. However, children requested adults' support to share further their endeavour through social media. When they reached the table of local policymakers, they played a political role by presenting their instances. Although the proposed tool sets the premises to start a constructive dialogue with public authorities, it did not offer support to children willing to share both the outcomes and the process they followed. Further research could explore how to turn the background journey performed by children into elements to shape this dialogue.

Finally, the overall laboratory experience created many occasions for many touching points and purposeful interactions amongst children and their technology-rich environments. This uncovered considerations on children's role in shaping and using technology. Specifically, the imagination of speculative artefacts demonstrated children's ability to recognize the gaps in their technical skills-set and their initiative to address them with judgement-free learnings, when it fits their overall change-making or provocative goals. Moreover, the use of a blended online/offline setup and the sharing of the analogue platform via social media showed the potential of digital media in bridging the divide between children as marginalised groups and adult decision-makers. This shapes future opportunities for new fluid and safe environments for children activism.

Conclusion

In summary, the current paper demonstrated that an activation journey based on a child-led approach represents a viable access point for children's participation in society when lacking top-down involvement from the institutions. Starting from the challenge of empowering children to take action for change-making in their community, the approach was iteratively prototyped. The outcome uses open-ended frame, alignment with children intuitive creativity, a child-friendly narration of change and alternation of thinking and making activities to unlock children initiative across 5 steps: raising I can mindset; finding relevance in opportunities for change; becoming protagonist of opportunities; powers-driven ideation; training courage. The approach pilot study showed evidence of children activation in either a protagonist, provocative or political role. Those inspire 3 future research directions: strengthening the rising of I can in correlation to children's protagonist role, exploring the potential of children speculative artefacts as a provoking means and turning the journey tools into elements to shape a dialogue with policymakers.

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Children Centered Living Lab Approach Development in Education

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Abstract

Information and Communication Technologies (ICT) are being developed rapidly in every field of life. ICT is expected to boost also children's education. The signs of the positive influence of ICT to children come from the use of active physical exercise games and established links between math achievements and the access to internet, number of computers at home and technology education. We aim to develop further the method of living lab in the field of education by exploring comparison techniques. The Living Lab is a process where children are involved as co-designers of the educational tools and environments. The work is a part of two large international projects: "Children Online: Research and Evidence" (CORE) and "Scaling up educational innovation in schools" (SEIS).

Author Keywords

Information and Communication Technology (ICT); education; Living Lab method; design-based research; validity; participatory design.

CSS Concepts

• Human-centered computing • Interaction design • Interaction design process and methods • Participatory design

Introduction

Our research interest could be broadly defined as an interest to study all sorts of impact of technological developments on children and youth in all possible digital settings. The technological developments are developments of information and communication technologies (ICT), in services, platforms, devices etc.

We would like to emphasize specifically two lines of our work that has been done and is continued: 1) how to study children's user experience of a software or a device in scientifically sound way [11,14,15,26], 2) digital knowledge sharing by adults and children using different kinds of platforms and networks [9,24,25].

The most motivating is the work that is already done about the positive influence of ICT to children. Positive influence of normal population children-ICT interaction appears in several fields. For example, videogames that involve active physical exercise (exergames) seem to encourage children to move more and raise the level of metabolic expenditure but more rigorous research is needed (see for review [2,10,22,28]). Also, in the field of education, the literature indicates that child's mathematics test score and

internet connection availability at home [6] and number of computers at home [21] are significantly positively correlated. Educational math games tend to have positive effect to math achievement of children with higher cognitive abilities [18].

Our general goal is to involve children to the process of ICT development (together with all other stakeholders) in order to enhance the positive influences of ICT on children. One methodology that fits that goal is Living Lab method that has been used for that purpose for decades. Our priority is to develop further methodologies that increase scientific benefits of children's involvement as developers of ICT.

Activity Theory [27] is often used in the studies that focus on the activities of people that involve interaction and relationship with the objects. Through their activities people constantly change and create new objects. The new objects are often not intentional products of a single activity but unintended consequences of multiple activities [4]. However, people do not always create by doing. Sometimes creative ideas come from observing or sometimes they come from making a mistake Engeström [5] states in general that community of practice or community of people, is a model of conception of activities, hence activity theory. According to Blackler [3] any knowledge creating and transferring activities form such activity system described by Engeström and predecessors. As main point in living lab activity is to transfer relevant knowledge on technology, users and use cases create in depth knowledge of topic on agenda. The knowledge creations functions are somewhat easier to comprehend, thus they are not the issue in this paper. Activity theoretical approach emphasizes creation of knowledge in practical situation, i.e. learning by doing or learning by cooperation.

Living lab method

Living lab (or design-based research) is a process of development of a product where producers, users and researchers work together. In other words, it is a real-life co-creation, test and experimentation environment that has at least four phases (Figure 1). To the best of our knowledge it was first described by Mitchell in the book about urban planning and living design [20]. Følstad [7] has said that living labs typically fulfil four aims. The method enables to: 1) evaluate or validate new IT solutions with users; 2) gain insight into unexpected ICT uses and new service opportunities; 3) experiment with ICT solutions in contexts familiar to the users, 4) enable long-term studies with users. Living lab is distinctive among other types of participatory design methods in at least two ways. As Ley and colleagues [17] have brought out a living lab provides mechanisms/environment for long term participation, possibly across more than one project, and it provides infrastructure for technologies in various stages of the development. The method has been in use for a long time and is well justified [1].

There are reviews about usefulness of living labs in ICT field in sustainable environment development [12] and in health issues [16] of adults but there are not many systematic meta-analyses on the research done on living labs in ICT involving children and education.

Designing for the future in living labs that develop digital educational tools for children

Further development of children centered living lab methodology for better use in education of youth and children between 7-18 years of age is the way we plan to design for the future.

Living lab's greatest potential is the possibility to implement scientific knowledge in practice and collect real life data for scientific purposes. It also provides creative ideas, real-life feedback and enables scientific analysis in order to develop digital tools or environments. We think it can be improved and developed further in a way that would enable even more precise conclusions about the validity and usefulness of a type of tool under construction [19]. We propose to add comparison with some similar tool or environment to living lab process in order to better validate the tool or it's certain characteristics. It is important to know that the benefits that occurred were truly evoked by the tool and are not the Hawthorn effects e.g. the side effects of the teamwork, assessment or new information obtained during the design sessions. In order to evaluate the validity and usability of a digital learning tool or environment it could be useful to compare it with the existing non-digital tool (like an educational tabletop game) or, if possible, with similar digital tool that already exists. The comparison is useful for the design development and evaluation of the tool and it may help to standardize the research protocol to collect the data that is also meta-analyzable. Doing only pre- and post-testing may not give information that is generalizable over the tool category or certain characteristics of the tools. For example, ideally meta-analysis of the living lab research data could give an answer to the question: what characteristics of educational software and environment enhance creative thinking or digital literacy or any other concept of interest?

It was discussed in the workshop "*Researchers' Toolbox for the Future: Designing the future of technology with and for children.*" that there are many studies that have used comparative approach in living labs involving children and experiences are twofold. From the pragmatic point of view the cost of comparison may outweigh the gains. Comparison costs time, may influence motivation to participate and social relations between children and require additional effort from researchers. For example, when organizing the comparison groups in a study where one group receives digital intervention and the other group does not, the children in non-digital group may feel disappointed and socially disadvantaged. The digital intervention group may feel socially superior [13]. On the other hand, there are studies where during one phase of a living lab categories of educational tools that differ in certain characteristics are compared to measure the effectiveness of these characteristics using within-subjects design [8,23]. The results are generalizable but still depend on what exactly is the aim of study. For example, Palmér [23] studied in one phase of a living lab apps that belonged either to weak framing category or strong framing category. Weak framing category means that the apps in that category were not directly meant for learning mathematics but had mathematics tasks integrated in them and strong framing category had apps directed to learning math. They concluded that math apps with weak framing and not with strong framing were the most beneficial in pre-schools for evoking teacher-student math related interaction. However, the result may not generalize to student-

student interaction. Their mentioned pragmatic difficulty was that it was hard to find apps that varied in the characteristics of their interest.

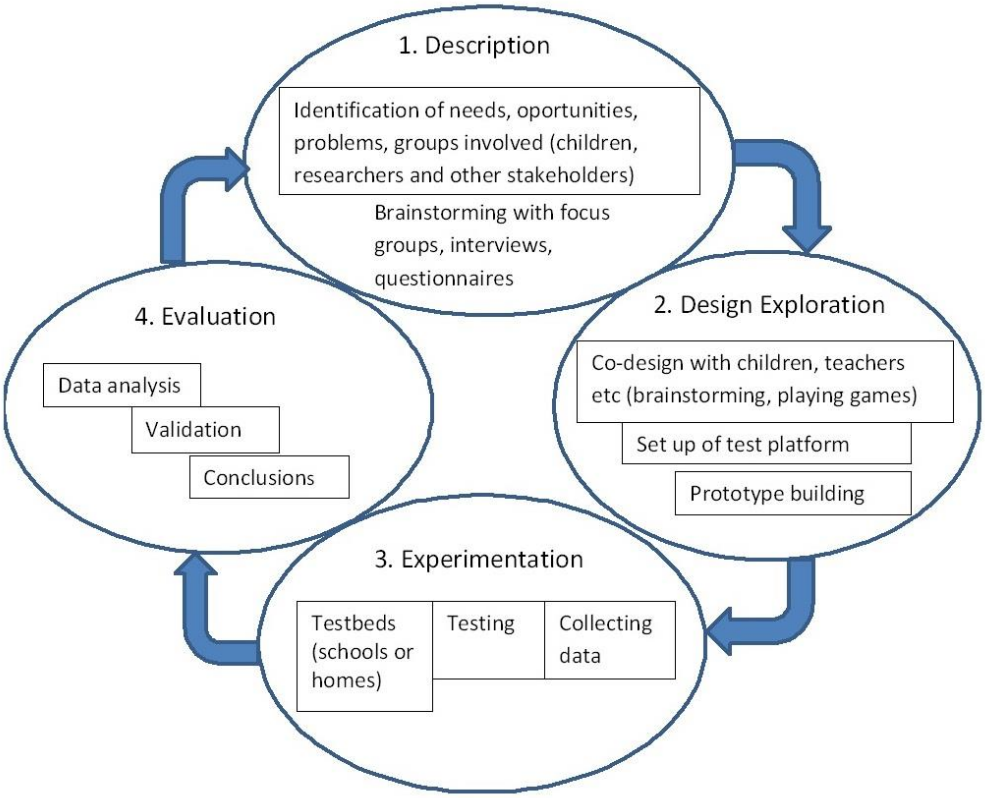

Figure 1. Schematic of living lab process

Future development projects – CORE and SEIS

There are two large projects we are proudly working on that line up well with the topic of "Designing for the future: children centered living lab approach in education": CORE and SEIS.

In the project "Children Online: Research and Evidence" (CORE) 10 participant organizations are working together to conceptualize, implement and disseminate a comprehensive knowledge base on the impact of technological transformations on children and youth. The CORE Knowledge Base will cover broad range of topics including children's health, lifestyles, participation and digital citizenship, wellbeing, safety, and security as affected by ICT. The CORE Knowledge Base will help researchers and research organizations to identify important research gaps and key topics in relation to technological transformations and children. In order to achieve these mentioned aims trusted and influential stakeholders will be involved and sustainable and dynamic infrastructure will be developed.

Conclusion

In both projects the participatory methods, such as setting up a living lab, serve as a vehicle for data acquisition where also the benefits of comparison can be pursued. However, as the living lab method is a method in wild it is sometimes accompanied by several shortcomings in social aspects and in scientific rigor. Implicit definitions and assumptions might require relaxing the test settings. If compared to orthodox controlled test settings, user research in wild is a hybrid of psychology, software engineering and domain study e.g. educational science or communication studies. Therefore, rigid application of any parent discipline might be affected and not thoroughly executed. Also, there could be a trade off in sense of practicality, i.e. burden of inquiry against validity and reliability. However, the data reflects actual use cases well and it provides valuable feedback loops for developers.

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Empowering Children as Co-Designers of Technology

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Abstract

Children of today form the edifice for the society of tomorrow. It is important to ensure they are well equipped to use technology to meet their needs, goals, and aspirations. This power to innovate, when placed in the hands of children, has the potential to develop confidence within them and empower them. However, this ability should not be limited to certain section of the population especially in countries such as India that suffer from a vast digital divide. In this position paper, we give an overview of our work in Child Computer Interaction and discuss how the values of empowerment and inclusion are central to our research projects.

Introduction

The Living Lab at IIIT-Delhi1 includes a team of faculty and young researchers who conduct research to understand people's attitudes towards and uses of technology. Our research focus explores the interrelationships between people, society and technology. Both faculty and student researchers conduct ethnographic fieldwork using a variety of techniques to identify requirements; improve usefulness and usability; and identify implications for how new technologies transform social life.

Increasingly, our group has been conducting research in partnership with children to understand their technology needs and preferences.

Taking children seriously as stakeholders who will eventually be affected by and use technologies, is becoming an important aspect of our research process. Inclusion is a key value in our research process and approach. Another value that we foster is empowerment because technology enables our stakeholders with the power to innovate and manifest new ideas that support their needs and concerns.

This power to innovate, when placed in the hands of children, has the potential to develop confidence within them to not only leverage the functionality that technologies offer, but to reimagine their worlds by designing technologies that meet their needs, goals, and aspirations. Thus, both inclusion and empowerment are two key values that drive our research process.

[1] https://livinglab.iiitd.edu.in/

Empowering Children Through Technology

Before the Covid-19 pandemic brought our fieldwork to a halt, we had embarked on a project; "Empowering Children in Urban Slums through Technology", in partnership with a local NGO learning centre in Delhi, India. Our aim is (after the lockdown is lifted) to understand how young girls at the learning centre could leverage technology to innovate and reimagine their world by empowering them to be technological creators. Our project will (once the lockdown is lifted) be guided by empowerment frameworks developed by Kinnula and Iivari [4].

Since the Covid-19 lockdown took effect in Delhi, our research has shifted its focus to understanding the rapid deployment and use of online learning initiated in both public and private schools due to school closures. We are studying how online learning is transforming students' experiences for children who are in their 10th year. The goals of study are to:

- Investigate how technology is being implemented to facilitate online learning and teaching due to school closures.
- Examine the differences between Covid-19 technology-based measures and the way the learning and teaching activities were conducted pre-Covid-19.
- Understand how students, parents, and teachers are adapting to this change including their needs and aspirations, and how they might reimagine the future of learning post-Covid-19.

Designing with Children

Understanding students' needs and aspirations for the future of online learning is crucial especially if this approach becomes a long-term trend. In technology design projects there are some cases where children are not involved as equals in the design process nor in the making of design decisions [5]. Many times, even if they are involved, their involvement is limited to a peripheral rather than a central role; for instance, evaluating prototypes defined and designed by others [1,2,5]. Some researchers have argued that children are not given the opportunity to make decisions that would affect design outcomes [3, 6]. Hence, they may be more often than not, disempowered in the design of technologies [6].

Within Child-Computer Interaction (CCI), children are viewed as key contributors in the technology design process [7]. Beginning with requirements gathering, CCI aims to ensure that the design journey is in the hands of children early on in the research process. Children's' ideas are taken seriously and their feedback is incorporated. Not only do children participate in each step of the research design process, they lead its direction from the first kick-off meeting to the last phase of prototype evaluation.

In our research, we have come to realize that guidelines and frameworks for involving children in design is crucial, so that we, as researchers, can give them the space, tools and guidance to explore their ideas. Guidelines can assist both researchers and developers in academia and industry to recalibrate the role of children from "end-users and evaluators" to "co-creators".

Recent Research: HapTech

One researcher in our team recently worked on a project, HapTech [8], which focused on the design of games for visually impaired children. In this research, her team explored how haptics and tactile interfaces could be harnessed to provide visually impaired children with an improved gaming experience that was relevant to their lived experiences. A key component of video games is their ability to provide life-like visuals. However, graphics prove to be ineffective when developing games for visually-impaired children.

The researcher and her team co-created a gaming console in collaboration with visually impaired children that provides a new source of audio and haptic, rather than visual feedback. The children engaged in a co- design process of the console especially in the development of innovative ways to support collaborative game play. These new interaction designs enabled the children to engage with the game in a way that was relevant to their lived realities - using the senses of touch and sound, making the game more relevant, meaningful and fulfilling to play. A result of this research has been the publication of the extended abstract: 'HapTech: Exploring Haptics in Gaming for the Visually Impaired' [8] at the ACM CHI 2020 conference as part of the Student Game Competition.

Discussion

Working alongside children, providing them with the tools to innovate, and co-create technologies presents them with the opportunity and the space to create positive and affirmational solutions and possibilities. And increasingly, the methods, techniques and topics of inquiry within the CCI community are becoming central to many of the research projects undertaken in our lab.

Our goal for attending the Researchers' Toolbox for the Future - IDC 2020 Workshop is to deepen our understanding of these tools, techniques and research orientations, and to learn from the variety of participants' experiences about how they engage children in technology design. Another goal will be to discover how our lab could incorporate CCI approaches into research projects. We also hope to share insights researchers from our lab have gained whilst working with children in an urban slum in Delhi. In particular, how empowering children through design can reach beyond the research study itself and impact the lives of everyone living and working in a community - including parents, teachers, and students.

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Intergenerational Aspect of Digital Fabrication and Making with Children

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Abstract

This position paper is written in line with the 'IDC 2020 Workshop 9: Researchers' Toolbox for the Future'. The focus of the workshop was exploring the methods that facilitate the design of children's future technological lives together with them. This paper provides introduction and background information about digital fabrication and Making in different contexts. Then, as the topic of this PhD study, some light is shed on the influential intergenerational aspect of design and technology making with children by elaborating on the value drivers, motivations and goals of a PhD study in relation to children and adults' roles in shaping children's technology rich lives. Nexus analysis as a suitable theoretical lens for making sense of complex topic is utilized for this PhD study. Furthermore, a reflection on the future of this PhD study's orientation inspired by the gaining from the workshop is discussed.

Author Keywords

Technology; children; participatory methods; empowerment; design; digital fabrication; Making; intergenerational; nexus analysis; values.

CSS Concepts

• Human-centered computing~Human computer interaction (HCI)~Empirical Studies; Participatory design; User studies; Qualitative research.

Introduction to Digital Fabrication and Making

The research topic for this PhD study is the intergenerational aspect of digital fabrication and Making with children. Digital fabrication refers to the process of design by human being using computer software, and then make of that design by machine which is basically controlled by computer and usually operated by human. Hence, it is a manufacturing process wherein a digital design is transferred into a physical object. And Making, being in harmonious relationship with 'maker mindset', encompasses concepts including but not limited to relationships, collaboration, confidence making, problem solving skills, sense of agency and belonging. *"Making is a source of innovation… Making is about developing one's full potential…Making can be a compelling social experience, built around relationships…"* [10].

Introduction to the Author's PhD Topic

My research is focused on the process of digital fabrication and Making for children. The intergenerational aspect of this study refers to the children themselves collaborating, learning and Making together as well as to the adult key actors (such as instructors, facilitators, mentors, pedagogical experts, researchers, teachers, parents and etc.,) who facilitate children's learning in the wide world of digital fabrication and Making [5]. Therefore, in my research, I am trying to lighten a part of this wide pathway by understanding how these involved actors shape children's learning by fulfilling variant roles, taking different responsibilities, adopting different strategies and ways of doing things, as well as interactions with children in digital fabrication and Making activities. Moreover, drawing an overall picture of children's group work activities and interactions during different processes of digital fabrication (such as 2D designing and laser cutting or vinyl cutting, 3D designing and 3D printing, electronics programming, and etc.,) would be another interesting aspect that this study will focus on.

Background

Nowadays, digital fabrication skill is considered as one of the most important 21st century skills which is the key to the success of people including children [3]. Digital fabrication and Making is happening in different contexts: formal, non-formal and informal [5]. In the formal context, since the potentials of digital fabrication and Making is revealed to a large number of researchers and practitioners from all around the world, there is a vast number of research going on (e.g., [1, 2, 7]) trying to understand the ways of integrating digital fabrication and Making into the school curriculum. One reason of doing such is the provision of better opportunities for learning STEM subjects by utilizing digital fabrication in the school projects. These formal activities usually happen in the school Makerspaces or classrooms. In addition, lots of DIY (do-it-yourself) or project-based activities take place as leisure time after-school activities in the informal Makerspaces, Fab Labs, libraries, museums, fairs and etc., equipped with the required space, tools and machines (e.g., [4, 6, 8, 11]). In my research so far, I have collected data from non-formal and informal contexts wherein children participated in the activities either voluntary or mandatory.

Methodology

My study belongs to the category of qualitative research, and is being developed by gathering in-depth insights mainly through engaging in field work (working in the Fab Lab) and conducting participatory design and technology Making workshops, interviews, and observation. As for the theoretical lens, I have been utilizing nexus analysis (closely linked to mediate discourse analysis) developed by Ron and Suzie Scollon [9]. Nexus analysis considers the social action as the key unit of the analysis which happens in the intersection of 'historical body' (our collected experience with social practice), 'interaction order' (different ways of interactions in different situations) and 'discourses in place' (means such as talks, objects, and concepts enabling the action or are used by us as mediational means in our actions) [9].

Whilst the interaction among the participants is a focal aspect to explore in my study, it is essential to also direct the attention to the various aspects of actors' characteristics and lifetime experiences such as their: prior experiences in digital fabrication and

working with children, education background, interests, aims for engagement and other history-related aspects. Also because the 'historical bodies' of the actors play an influencing role on their current interactions, here is where I have taken the advantage of utilizing 'historical body' and 'interaction order' concepts of nexus analysis approach as the theoretical lens for conducting my research so far. Moreover, the focus of my current analysis in hand is mainly on the concept of 'discourses in place'. I have been trying to identify the place discourses (how the place is supporting or hindering the action) as well as the interaction order discourses related to the task (such as talks and image making of own and the people—e.g., instructor, group mates, and etc.).

Driving Values, Motivations and Goals

This study is motivated by several pioneer researchers in INTERACT research unit—having roots in human-computer interaction and Scandinavian participatory design with children. The driving values, motivations and goals of my study is in line with our research group with a major research theme of children's participation and agency in issues concerning their lives. Thus, the following four value drivers stemming from the empowerment value contribute to the enhancement of children's technological lives:

- Creativity: I value children's active and creative participation in technology Making activities. Children should be shifted from the direction of being merely the consumers of technology to being the creators of technology; simply because they are the future innovators. I observe or arrange children's engagement in those digital fabrication and Making activities which involve them in ideating, designing, creating, problem solving and prototyping in an iterative manner. These activities foster their creativity and lead to innovative creations. It is worthwhile to note children's confidence enhancement as another consequence of this engagement.
- Autonomous and collaborative learning: I consider children as important human beings, believe in them, trust them and treat them with respect as I treat adults. Moreover, children's active participation in digital fabrication and Making activities has the potentials of developing independent learning and self-regulating skills where they are not in need of close and direct guidance from the adults for learning—in order to reach the fact-paced technological world they are in need of such skills. In addition, through the collaborative designing and Making activities children's social and communicative skills will be enhanced.
- Do-it-yourself: by getting familiar with these processes, children would be empowered to repair their stuff and also to design and make some things instead of buying them—referring to the valuable idea of DIY & sustainability & consumerism.
- Human values: although the encouragement of independent learning is a focal point, children still are in need of adult's help for both 'learning to learn independently' and 'asking help when facing challenges'. My research is about children and technology Making, but with an emphasis on the critical role of the adults which contributes in either shaping a pleasant and fruitful learning experience for children, or an unpleasant and unsuccessful one.

Project Overview: Current Status and Future Orientations

As a researcher in the area of digital fabrication and Making, I am happy that I personally have been closely involved in the Fab Lab activities. Having a Fab Lab in the University of Oulu, provided me with the opportunity of working in a Makerspace and familiarizing myself closely with the process of digital fabrication. At the beginning of my PhD, I accomplished FabAcademy; a 6 month course comprised of different weekly assignments focusing on learning different processes and meanwhile, elaborating on a defined final project during each week (Figures 1-5). Since at that time I also had started reading the literature related to digital fabrication for children, it left a mark on my mind to start prototyping a tool that facilitates collaboration and social interaction of the active and interested children in digital fabrication activities. After finishing FabAcademy, I started working part time in the Fab Lab Oulu as Fab Lab instructor.

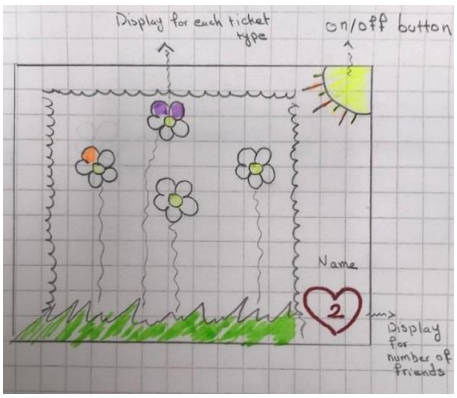
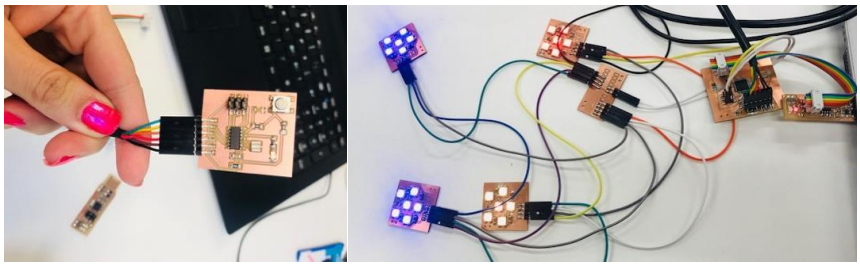


Figure 1: A sketch of the ideating stage of my FabAcademy project



Figures 2 and 3: Some results of electronics design, production and programming of my FabAcademy project.

In Fab Lab Oulu, during last 2 years, we have been hosting lots of class visitors from different schools, mostly with the purpose of getting to know Fab Lab and engaging in small and short-term projects, usually 1-day workshops. In addition, I also engaged in longer projects (e.g., 2 weeks) with class participants and summer workers in the Fab Lab. Furthermore, the presence of an electronics and robotics club in the Fab Lab have attracted lots of volunteers and interested children as the club members, where they design and create whatever they like in their leisure time and as after-school activities. I also organized a few 1-day design and making workshops for family participants and university students. Moreover, we took mobile Fab Lab a few times to different schools to do small laser cutting and electronics activities with children.

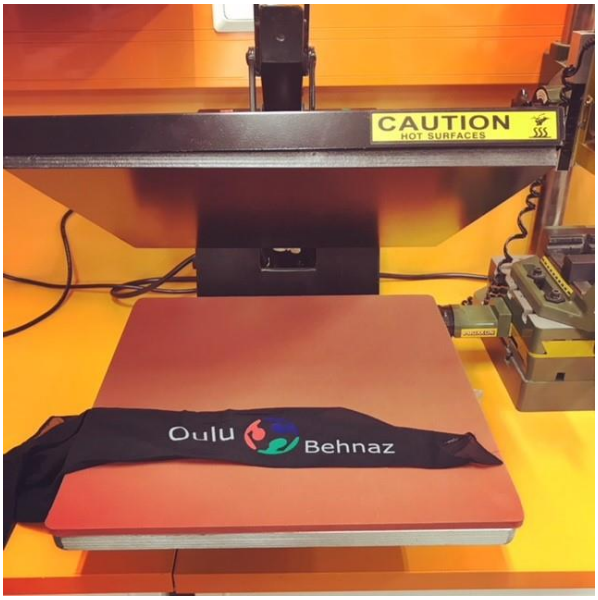


Figure 4: The Fab Lab logo and my name in this image are first designed in Inkscape (a vector graphic software), then cut on a vinyl material by using vinyl cutter, and finally printed on a piece of fabric using heat press machine (the machine shown in the picture).

To put it in a nutshell, I have had the opportunity to witness: lots of screams of happiness and joy because of the successes, and also cries because of failures; lots of smooth or challenging situations; lots of positive and some negative interactions; lots of engagements and discouragements; and different ways of instructing children's activities. Considering my fresh presence in this field, I believe my engagement in all of these activities has opened my eyes to a wide range of possibilities and challenges, and therefore has prepared me for finding my path and organizing my own future long-term workshops with children with the purpose of contributing to the children empowerment specifically by in-depth understanding of the intergenerational aspect of the activities, as explained earlier in this paper.

Furthermore, the 'Researchers' Toolbox for the Future' IDC workshop not only revealed the lack of critical research related to children and technology (specifically design and Making) among CCI researchers, but also shed lights on the significance of taking children as experts into design and Making activities as well as providing them with the chance of criticizing and questioning things. All in all, I am confident in taking some steps forward to the further development of my future project with children; and in doing such, I am considering the inclusion of some aspects of critical design and making into my research because I believe giving children strong voices is in harmony with the themes of creativity, autonomous learning and human values which are some of the important value drivers in my research.

Figure 5: In this image you can see the final product of my FabAcademy project named MakerGarden. The lights are controlled by a mobile app. MakerGarden is created by using the most common forms of digital fabrication process: 2D design & laser cutting; 3D design & 3D printing; PCB design & production & programming; adding input & output device to the microcontroller board that I designed; and interface & application programming

Conclusion

The workshop topic was focused on designing children's future technological life via participatory approach. My research topic is about the intergenerational aspect of facilitating children's empowerment in the wide world of digital fabrication and Making, which is comprised of co-design and co-creation of technology. Active involvement of children in technology Making or Making with technology and exploring ways of providing support to them in this process were critical in both topics. Though, children's empowerment in technology Making is a wide topic with several essential aspects among which the intergenerational aspect is the focus of my research with several themes of driving values such as creativity, autonomous and collaborative learning, do-it-yourself as well as human value referring to the adults assisting children in the meandrous journey of technology design and Making.

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Research Toolkit for Family Speculative Play with Future Toys

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ABSTRACT

In this paper, we aim to share guidelines that will help designers and researchers create meaningful, novel, and collaborative future games and toys for families. We bring together best practices from game design and the study of family intercommunication so that family members can bond, collaborate, and ideate while having fun. We develop these learnings through a preliminary scan of existing family play-interaction guidelines and comparing them to indie as well as popular digital toys, apps, and games. We conclude with several reflective tools for measuring and assessing games and toys for family-centered play.

Author Keywords

Family play, Smart Toys, Participatory Design

Introduction

Today, we see more and more toys and physical play being replaced with mobile applications, digital games, and streaming services. While developmental psychologists and pediatricians recognize the importance of physical play in kids' development, we see that families spending less time engaging in collaborative play and widely adopting technologies in their homes that are not necessarily developmentally appropriate [49, 48].

As of February 2017, YouTube Kids counted over 8 million active users, with over 30 billion views made in the app. 81% of US parents with kids under the age of 11 say they allow their child to watch YouTube, with 34% saying their child regularly watches content on YouTube [40]. At the same time, an estimated 3.25 billion digital voice assistants are being used in devices around the world. Forecasts suggest that by 2023, the number of digital voice assistants will reach around eight billion units [39].

Research on families' interactions with smart toys and new technologies is a growing area with implications for speculative play design [30, 16, 36]. As devices become more human-like in form or function, humans tend to attribute more social and moral characteristics to them [25]. These findings raise the question of parental engagement and interventions in children's interaction with connected toys and intelligent agents [16, 49], and it also raises the opportunity to involve families in future smart toys and games design [28, 50, 8]. In this context, we wonder what the future of play for families looks like and how can we best support researchers and designers to engage with families in order to create future toys and games. We contribute a new toolkit for

families to co-design speculative play and present three examples of future toys that were assessed by this toolkit. We aim to advance research on the family's conceptualization and interaction with future technologies through play in various social, economic, and cultural settings [44, 1, 16, 34]. These initial explorations aim to engage a broader conversation around ways to design inclusive play artifacts and experiences for and with a diverse group of families.

Related Work

In order to inform our analysis of existing and future play scenarios we look at research on playing and speculative design, studies on socio-cultural values for family-tech toys and games and existing methodologies for play co-design with families.

Playing and Futuring

Games and toys often enable creative exploration, relationship-building, meaning-making and fun to emerge when players learn and master the rules and context of play. [27]. Formal games provide structured interactions among players through a democratizing space of a "magic circle", a term used by ludic scholar John Huizinga [23], to denote a "third space" that is created outside of everyday life's power structures. Play is also a powerful lever for inter-generational relationship-building [10]. Positive social-emotional learning outcomes are drawn from joint media engagement studies. For example, in Electric Race: an inter-generational gaming experience for promoting literacy, parents and children earn more points when they play the game together, as adults actively share prompts that boost the learning outcomes [42]. When adults and children play together, adults can improve their digital and media literacy skills, while children are more likely to improve their cognitive, social, and emotional development skills [46].

A common strategy for considering the future, involves mapping probable, possible, and preferred futures [29]. Designers from the "games for good" communities and public engagement engagement practitioners have created games where players can practice civic skills like democratic participation, citizen science, and cross-cultural learning as well as engage in critical speculation and futuring. For example, the game @Stake game enhances civic creativity as players ideate solutions to solve public problems by playing different community roles [21]. Architects, urban planners, and community organizations have used games like this to facilitate participatory design and scenario planning [5]).

Game and toy designers must articulate their vales when designing for futuring and consider inequities, such as who gets to design for the future, whose futures are included in players' imaginations, etc. For example, the NGO Coding Rights developed The Oracle for Transfeminist Technologies to envision and support technologies designed by and for the most marginalized groups. Though there are many game examples that encourage critical reflection and futuring, we did not find games or toys in this vein designed specifically for families. While game design often relies on structures like rules and turn-taking, there are also opportunities to playful engage families in more emergent and passive ways. For example, when family-centered HCI research first appeared in the CHI and IDC literature, researchers encouraged the use of cultural probes [24] [33], which proved to be not only generative, fun, and engaging but also

productive for co-design outputs. Designers have the opportunity to apply guidelines from game design, child learning, and speculative design practices to create playful and future-oriented activities for families.

Beyond formalized games, ludic- or playful, design can be incorporated into a wide-range of interactions for tool-use, entertainment, art, information seeking, communication, and toys themselves especially for domestic technologies. Design researchers have found many benefits from open-ended, playful explorations of domestic technologies such as aesthetic appreciation, invigorated curiosity, and increased social engagement [20]. It is also important to note that the field of social impact games is fragmented in its definition of social impact itself [41]. While many "social good" games are set in the future or enact a future-oriented simulation, there are few examples that invite families to co-design futures.

Socio-Cultural Values for Family-Tech Toys and Games

As we embark on this journey, we recognize the importance of an inclusive family tech-toys and games designed for multi-cultural and multi-lingual families from different socioeconomical backgrounds. This approach requires that we avoid WEIRD populations [22] both in the group of people we work with but also in our team of researchers. Thus, we recognize that as Medin and Bang describe [31], the answers to our research questions will be impacted by "who is asking." In our co-design research, our unit of measure is the practice of how families engage with AI technologies in their daily lives [38]. We situate this practice in the constellation of socio-cultural practices that families have developed [35]. Our work builds on prior work on multi-cultural families technology literacy and joint-media engagement [2, 32].

As we discuss designing for family interactions, we want to highlight that it is essential to accommodate the diversity of family structures. More often than not, the contemporary family in the United States does not resemble the nuclear family. As HCI researchers have noted, our designs must take into account family configurations that include divorced, samesex, dealing with death, work-related periodic separation, and reunion, military, single-parent household [26].

Co-design with Families

Parents help scaffold their children's behavior when interacting with robots or interactive devices together [7, 19]. We observe the same behavior when families interact with VUIs (Voice User Interfaces), and parents help children repair various communication breakdowns with the conversational agents [3].

Prior work examining children's use of media, proposed an updated framework for parental mediation that includes participatory learning in which both children and parents interact and learn together through digital media [9]. Our current study explores the field of family speculative play by examining families' understanding and perceptions of various technologies and science concepts presented to them in the form of digital games they can play with, and modify. Building on parental mediation and JME frameworks [42, 43, 51], we aim to analyze and support future games and toys co-design with families.

Guiding Values for Family Co-Design

We consider that access to knowledge, when done right, can have equalizing force in society and help address some of our most pressing issues when it comes to increasing inequalities, discrimination, and power abuse. Our goal is to allow families to discover how some of the most intriguing discoveries in science and technologies could be tamed or re-purposed. By Incorporating the value of transparency, designers can be explicit about the power dynamics of play: whether the game or experience is child-driven, designed for reciprocal levels of engagement, or intentionally open for interpretation. We prioritize three values for designers to consider incorporating into game-play. The first value, transparency, requires a reckoning with the power dynamics reproduced in play. Children's sense of agency, efficacy, and emotional connection can greatly vary in child-driven play versus more balanced play dynamics. We encourage designers to intentionally reflect or explicitly share whether their games are child-driven, adultdriven, or include more balanced family play dynamics. Next, we propose a focus on participatory design as a guiding value. This democratic value is well-aligned with the emancipatory ethos of critical design and socially-responsive design. Various participatory design studies with children have demonstrated the affordances of this method to level out power dynamics between diverse stakeholders to foster more constructive dialogues [6], [47]. Finally, we note a value of designing with playfulness, such as through whimsical game elements or encouraging explorative and open-ended play. Recent studies have shown that a playful approach to co-design activities and games enables greater genuine participation. The value of playfulness compliments the value of participatory design as it has shown to be in service of children's roles as co-designers [18], co-researchers [12], and even process designers [37] In our prior workshop on co-design at IDC'20 participants underlined the importance of considering children as experts of their lived experiences when designing futurist technologies for them. In our current inquiry we investigate how that positioning translates when putting families at the center of the speculative future play design.

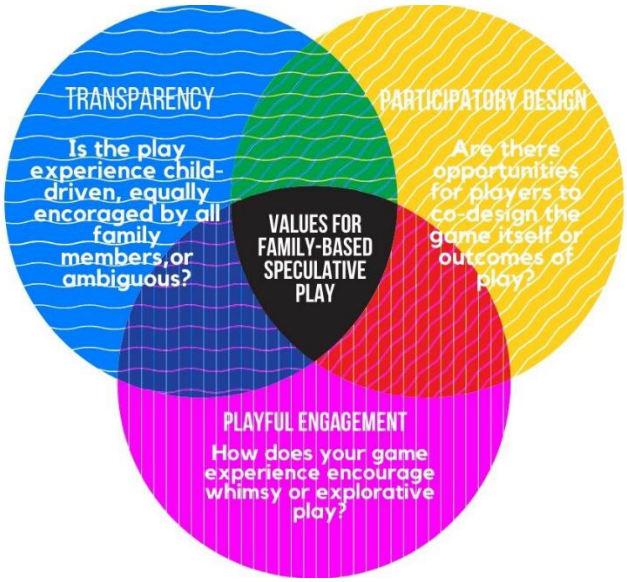

Figure 1. Values for Family Centered Speculative Play

Designing for Families Playing Together

Critical Play for Families

Critical play scholar Mary Flanigan defines critical play as the "means to create or occupy play environments and activities that represent one or more questions about aspects of human life," and "is characterized by a careful examination of social, cultural, political, or even personal themes that function as alternatives to popular play spaces". This type of play for families has potential to promote resiliency in the face of intersecting global catastrophes, including pandemics, climate change, and the impacts of systemic racism. As more family members work or learn remotely during the COVID-19 pandemic, games can create a temporary "third space" [4] for families to experiment with expression, learning, and bonding amidst trying times. While in our research, we could not find examples of critical play geared toward children and youth, the indie game community offers inspiration from h many games that invite critical social commentary, such as Dog Eat Dog (produced in 2012, a game about colonialism and its consequences) and Molleindustria's Phone Story (produced in 2011, a game about the production of smartphones). While these games primarily target adults, we propose applying the values and framework in this paper to adapt critical games for family-centered play. We recommend that toy, game, and playful interactions designers assess prototypes and products based on several relational and user experience dimensions, as well as opportunities for reflection (since reflection is a critical part of speculative design).

Figure 2. Demo prototype "Ballbit" toy

Implementing these scales and guidelines can support a wide range of meaningful engagement, fun, and literacy of more advanced concepts such as machine learning and algorithms. The scales in Figures 3, 6, and 9 invite users to assess how holistic their designs are for family engagement. In order to illustrate how designers or families might use our research toolkit, we placed three bespoke games on the spectrums of player passivity vs. action, solitary playing vs. collective playing, free-form vs. rule-heavy mechanics, mental vs. physical formats, and male vs. female themes. The bespoke toys include: Humming Box (a multimodal musical creation toy), Ballbit (an interactive

maze where children collaborate to solve challenges), and Shake It Off (a movement-based game to change virtual scenery).

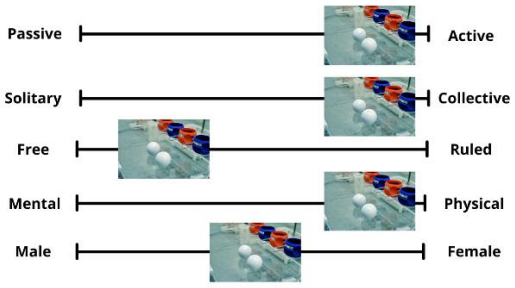

Figure 3. Kids play-testing "Ballbit" toy together, Figure 4. Scale of play for "Ballbit" toy

Considering these dimensions throughout the game and toy design and development process can promote a well-rounded approach to intergenerational learning and social engagement. Future toys and games can be evaluated for quality and familyfit along these dimensions while noting possible emergent tensions such as unbalanced gender dynamics. The principles ranging in Table 1 (mutual engagement, co-creation, boundarycrossing, collaborative inquiry, intention to develop, and focusing on content instead of control) build on the influential work on families' joint-media engagement [42]. We assessed the bespoke toys again based on these guidelines, noting which of them were partially or fully implemented (See Table 1).

Design principles	**Definition**	**Ballbit**	**Humming Box**	**Shake it off**
Mutual Engagement	Equally engage in the activity	**	**	**
Co-Creation	Use toys and games to create experiences that are good & meaningful	*	*	*
Boundary Crossing	Interactions are informed by past individual experiences & interests		**	**
Collaborative Inquiry	Collaborate via conversations to understand the game/toy	**	*	**
Intention to Develop	Develop awareness of their interest of AI	*	*	
Focus on Content	Focus on the content and play & minimize technical considerations	*	**	*
**featured *partially featured				

Table 1. Custom Toys Family Play Interaction Analysis based on guidelines adapted from Takeushi et al. \cite{takeuchi2011new}

Relational recommended guidelines include: mutual engagement (where family members build off each other's participation), co-creation (collaborative creativity), and collaborative inquiry (understanding a game or playful interaction together). Guidelines related to explicit intentions include: boundary crossing (such as sharing personal stories), focusing on content rather than physical and technical constraints, and engaging with the intention to develop self-awareness of that of other's needs and/or interests. We are motivated to review how family interaction design guidelines are being applied in current game and play designs in order to create a more standardized tool for family play designers. First we conduct a preliminary review of several guidelines for family interaction design and synthesized their findings (Table 1). With these best practices in

mind, we reviewed the top twenty apps in the Apple Store geared toward family play, as well as the top-selling and games and electronic toys sold in Amazon (Table 2). We found that some of the most popular digital apps and games for families are re-makes and re-releases of popular games such as Monopoly, Family Feud, Uno, Charades, etc.

Other popular digital games include supplements to tools like voice assistants- such as themed trivia games, puzzles, and board game adaptations. While we searched for games that have been directly marketed as fun for the "whole family", we are also aware that anecdotally, many games have been adapted by families to be played together (such as augmented reality games such as Pokemon Go or all-ages pictionary and charades style games such as the Jackbox suite). In reviewing these games, we assesed which of the relational recommended guidelines were met. Most games included the principles of "mutual engagement" and "collaborative inquiry", however few games included co-creation, boundary-crossing, and intention to develop.

To address future-oriented play design, researchers can include elements of future-oriented ideation, reflection, and creative collaboration toward preferred futures- such as with in-game mechanics or with reflection moments throughout a game or toy experience.

Authors' Positionality

Stefania: Curious Mind

In presenting these initial ideas and future vision for my research with multi-cultural families,position myself primarily as a Romanian, Eastern-European activist for better and more inclusive technology education. Before deciding to embark on a P.h.D. Journey, I worked for more than eight years on handson STEAM education in different communities around the world as part of the organization I created called HacKIDemia. I learned seven languages and lived studies and worked in more than ten countries until the age of 33 years old. This international experience allowed me to gain a glocal view when it comes to community engagement and pedagogical approach. In the past three years, I lead multiple co-design sessions with families focused on AI literacy [16, 17, 15] and created Cognimates, one of the first platforms for AI education, which is free and open-source [14, 13].

Rebecca: Family Futurist

I am collaborating on this toolkit, as a first-generation American whose family immigrated from the former Soviet Union. Growing up in San Francisco instilled in me the appreciation of diversity and curiosity for creative experimentation while witnessing inequities that can come with technological innovation. I worked in an applied research lab on civic media and technology, where our design research team created experiential learning opportunities such as hackathons, games, and co-design workshops. My projects included game-based learning, public engagement research, and postpartum healthcare innovation [11]. These experiences motivated my pursuit of graduate school, where I situate my research at the intersections of family well-being, technology, and participatory design. Specifically, I am interested in developing theories and methods that enable a deeper understanding of family life, their caregiving needs, and the role of technology so that families may grow healthy and resilient, together.

Type of gameplay	Game or Toy Name	Co-viewing Guidelines
Boardgame	Watch Ya Mouth	Mutual Engagement, Collaborative Inquiry
Boardgame	STEM Family Battle	Mutual Engagement, Collaborative Inquiry, Intention to Develop
Boardgame	Kids Against Maturity	Mutual Engagement, Focus on Content
Boardgame	Flarts (Floor Dart Game)	Mutual Engagement, Focus on Content
Boardgame	Hedbanz	Mutual Engagement, Collaborative Inquiry, Focus on Content
Boardgame	Twister	Mutual Engagement, Collaborative Inquiry
Boardgame	Family Feud	Mutual Engagement, Collaborative Inquiry, Intention to Develop
Smart toy	Shifu Plugo Count	Individual play, Intention to Develop
Smart toy	Vector Robot by Anki	Individual play, Intention to Develop
Smart toy	WowWee Toy Robot	Individual play, Intention to Develop
Smart toy	Osmo - Genius Kit For Ipad	Individual play, Intention to Develop
Smart toy	Drone toy	Individual play, Intention to Develop
Smart toy	Yoego Robot	Individual play, Intention to Develop
Family Coding	Tangiplay: Code N Play	Mutual Engagement, Co-Creation, Collaborative Inquiry, Intention to Develop
Family Coding	ThinkFun Hacker Game	Mutual Engagement, Collaborative Inquiry, Intention to Develop
Digital to analog	Minecraft Uno	Mutual Engagement, Content Not Control
Digital to analog	The Science Game: Alexa Skills	Mutual Engagement, Collaborative Inquiry, Intention to Develop, Focus on Content
Digital to analog	Ticket to Ride: with Alexa	Mutual Engagement, Collaborative Inquiry
Digital to analog	When in Rome Trivia: with Alexa	Mutual Engagement, Collaborative Inquiry, Intention to Develop
Digital to analog	St. Noire Cinematic with Alexa	Mutual Engagement
Digital to analog	Monopoly: with Alexa	Mutual Engagement, Collaborative Inquiry
App	Charades	Mutual Engagement, Co-creation, Focus on Content
App	Monopoly	Mutual Engagement, Collaborative Inquiry
App	Draw Something	Mutual Engagement, Co-creation, Focus on Content
App	Worms 3	Mutual Engagement, Collaborative Inquiry
App	Family Feud	Mutual Engagement, Collaborative Inquiry, Intention to Develop
App	Catan	Mutual Engagement, Collaborative Inquiry
App	Bejeweled	Mutual Engagement, Collaborative Inquiry, Focus on Content
App	Quiz Up	Mutual Engagement, Collaborative Inquiry, Intention to Develop
App	Scrabble	Mutual Engagement, Co-Creation
App	Uno	Mutual Engagement, Content Not Control
Subscription Box	Awesome Pack	Mutual Engagement, Intention to Develop
Subscription Box	The Salty Owl Studio	Mutual Engagement, Co-Creation
Subscription Box	Slime	Individual play
Subscription Box	We Craft Box	Mutual Engagement, Collaborative Inquiry, Co-Creation
Subscription Box	Wonder Co	Individual play
Subscription Box	Brick Loot	Individual play
Game	QQFarm	Mutual Engagement, Collaborative Inquiry, Focus on Content
Game	Save Amaze Princess	Mutual Engagement, Collaborative Inquiry, Focus on Content
Game	Xtreme Gardener	Mutual Engagement, Collaborative Inquiry, Focus on Content
Video Game	Find It	Mutual Engagement, Collaborative Inquiry
Game	Toy Generations	Mutual Engagement, Collaborative Inquiry

Type of gameplay	Game or Toy Name	Co-viewing Guidelines
Video Game	Farmer's Animals	Mutual Engagement, Collaborative Inquiry
Gesture game	Virtual Soccer	Mutual Engagement
Game	Blast from the Past	Mutual Engagement, Collaborative Inquiry, Intention to Develop
Augmented Reality	Curball	Mutual Engagement, Collaborative Inquiry, Content Not Control
Mixed Reality	Virtual Box	Mutual Engagement, Collaborative Inquiry, Content Not Control

Table 2. Summary of commercial games and toys analysis

Conclusion

As technology becomes increasingly integrated into daily life, design researchers can design for play that is "together together", rather than perpetuate the anxiety of being "alone together" where people are co-located but socially isolated on devices [45]. With increasing trends in smart, STEM-based, and mixed reality toys, there are tremendous opportunities to orient toy and game design for family engagement, rather than individual play. While these play potentials are on the horizon, we encourage designers to keep their values at the center of play development in an ever-evolving digital landscape where the novelty of new technology can put privacy at risk. This toolkit aims toWith our toolkit we aim to support future-oriented toys and games co-design and reflection for families.

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