Designing the Internet of Toys for and with Children: A Participatory Design Case Study

van Mechelen, Maarten; Zaman, B; Bleumers, Lizzy; Marien, Ilse

Publication date
2019

Document Version
Final published version

Published in
The internet of Toys

Citation (APA)
van Mechelen, M., Zaman, B., Bleumers, L., & Marien, I. (2019). Designing the Internet of Toys for and with Children: A Participatory Design Case Study. In G. Mascheroni, & D. Holloway (Eds.), *The internet of Toys: Practices, Affordances and the Political Economy of Children's Smart Play* (pp. 181-203). (Studies in Childhood and Youth).

9

Designing the Internet of Toys *for* and *with* Children: A Participatory Design Case Study

Maarten Van Mechelen, Bieke Zaman, Lizzy Bleumers and Ilse Mariën

Introduction

The phenomenon of the Internet of Toys presents media scholars with both theoretical and methodological challenges. On a theoretical level, it taps into recent discussions calling for a better understanding of how children's online and offline experiences blend into one. The Internet of Toys embodies hybrid experiences where the digital and physical

M. Van Mechelen (✉)
Delft University of Technology, Delft, The Netherlands

M. Van Mechelen · B. Zaman
KU Leuven, Leuven, Belgium
e-mail: bieke.zaman@kuleuven.be

L. Bleumers · I. Mariën
Vrije Universiteit Brussel, Brussels, Belgium
e-mail: Lizzy.Bleumers@vub.ac.be

I. Mariën
e-mail: ilse.marien@vub.ac.be

G. Mascheroni and D. Holloway (eds.), *The Internet of Toys*,
Studies in Childhood and Youth, https://doi.org/10.1007/978-3-030-10898-4_9

coincide on a technological level (Zaman, Van Mechelen, & Bleumers, 2018). To date, however, previous literature has mainly focused on how to study existing Internet of Toys applications, but few studies have focused on how to design new connected toys (e.g. McReynolds et al., 2017), let alone how to design them for and with children. Maintaining a multi-perspective lens throughout the design process, while reconciling technological and social demands, necessitates several stakeholders collaborating (Donoso, Verdoodt, Van Mechelen, & Jasmontaite, 2016). When envisioning children as end-users and considering them as people who have the right to be heard about matters affecting their lives (Livingstone & Third, 2017), the question then arises of how to give children *a say* in the design of Internet of Toys applications.

The aim of this chapter is to discuss participatory design (PD) strategies that can be used in interdisciplinary design projects for new Internet of Toys applications. From its origins, PD was driven by democratic and emancipatory values to empower envisioned users of the technology, including children, as legitimate participants in the design process. Similar values are expressed in the Convention on the Rights of the Child (United Nations, 1989). More particularly, the chapter presents the WOOPI project as a case study to ground methodological reflections. The overall aim of the chapter is to shed light on how participation in the design process can empower children, and what kind of knowledge is generated and validated in this context.

Participatory Design

PD is an '*approach towards computer system design in which the people destined to use the system play a critical role in designing it*' (Schuler & Namioka, 1993, p. xi). It is a diverse field, with by a rich history and drawing on different disciplines including the social sciences, software engineering and design.

A Brief History

PD originated in Scandinavia in the 1970s and 1980s out of a democratic commitment to empower workers in an increasingly computerized work environment. The idea was that those who would use or be impacted by technology in the workplace should have a critical role in its design (Robertson & Simonsen, 2013). This premise to give workers a voice had its roots in society at large. Since the early '60s, various social, political and civil rights movements had been striving for more decision-making power for those affected by these decisions. Motivated by the values of democracy, action researchers partnered with labour unions to enable workers to co-determine the shape and scope of the technology in their workplace (Spinuzzi, 2005). These early PD practitioners saw themselves as facilitators who attempted to empower workers to make their own decisions, which they considered a basic human right (Clement, 1994). The ultimate goal was to develop inclusive and democratic design solutions (Robertson & Simonsen, 2013). This ethical stance, that still underlies PD today, stems from a responsibility to consider the impact of design on people's lives and environments. Often cited in this context are Winograd and Flores (1986, p. xi): '*We encounter the deep question of design when we recognize that in designing tools we are designing ways of being*'.

The political and emancipatory rationales of PD went alongside more pragmatic ones; users[1] and designers[2] had to learn from each other in order to develop suitable technological solutions. Users were seen as experts in their work domain, and designers as experts in the design process and technology in general (Robertson & Simonsen, 2013). However, in the early years of PD, most technology was custom-made for the workplace and PD typically addressed small-scale systems. Corporations nowadays are increasingly buying generic software, and, at the same time, technology use has expanded into our homes and leisure time. This proliferation of new technologies and domains has widened the scope of PD, making it increasingly difficult to anticipate all different use practices, both desirable and undesirable ones.

In addition to this widened scope, PD has achieved the status of a useful commercial approach to developing better consumer products. Involving users is believed to give better insights, which could not have surfaced otherwise. In this discourse, PD is often framed as simply a design method to optimize outcomes, i.e. a user-friendly and desirable solution. In this pragmatic view of PD, decision-making power is more likely to remain in the hands of the designers, whereas sharing decision-making power used to be an explicit goal of PD (Frauenberger, Good, Fitzpatrick, & Iversen, 2015). Although this mainstreaming of PD has not been greeted by all with enthusiasm, PD has had a profound influence on the recognition of the value of user participation in design (Muller, 2002).

Core Principles

Reflecting on PD's rich heritage, three core principles can be distinguished that form the backbone of PD: (1) *having a say* or the sharing of decision-making power between designers and users; (2) the continual process of *mutual learning* between these participants; and (3) and the iterative, collaborative development or *co-realization* of future technologies and practices (Bratteteig, Bodker, Dittrich, Holst, & Simonsen, 2013).

Having a Say

The first principle, *having a say*, refers to users having influence on the actual outcome of the design process, and it relates to participation and decision-making power in design (Bratteteig et al., 2013). Having a say means going beyond a one-directional information flow whereby users voice their opinions, but designers make the final decisions. For designers, it is often difficult to share their decision-making power with users, because it may infringe on their autonomy and design expertise, or at least they may view it in that way. At the same time, having decision-making power may also be difficult for users who are not used to having such power, because it implies shared responsibility for the direction and outcome of the design process. In addition, designers tend to define design problems in a top–down fashion based on their expertise (e.g. technical knowledge), which makes it difficult for those without this knowledge to genuinely participate in the design process. This phenomenon, whereby designers have symbolic power over users in the design process, is referred to as *model monopoly* (Braten, 1973).

To address model monopoly, PD takes actual use practices as the basis for design instead of designers' preconceived ideas about users, and a broad variety of stakeholders are invited to join the design process to expand the universe of discourse (Bratteteig et al., 2013). In addition, a problem statement rather than a fixed goal or research question is used as a starting point for design to further increase users' influence. Relying on Schön (1983), problem-setting and problem-solving are thereby regarded as intertwined and inseparable. This means that users co-determine the agenda (what is being discussed) and the scope of the design process (which problems are defined and judged relevant), and they envision and concretize ideas together. This process requires continual participation, revisiting earlier steps and sustained reflection (Spinuzzi, 2005).

Mutual Learning

The second principle, *mutual learning*, refers to the learning process between users and designers. This is a two-way process, in that designers learn about the use context from the users, and, in turn, users learn about the design process and technical possibilities from the designers. The basic idea is that no participant knows everything and a process of mutual learning is necessary in order for participants to respect and recognize each other's expertise. This mutual learning process develops when users and designers jointly and creatively explore the design space (Bratteteig et al., 2013).

Users' knowledge, however, is often difficult to tease out because of its tacit nature. Tacit knowledge refers to the kind of knowledge that cannot readily be expressed in words (Polanyi, 1983), but requires sustained and iterative reflection on the user's current practices and/or use of a designed artefact (Spinuzzi, 2005). Ehn (1993) has referred to this process as *collective reflection-in-action*, meaning that mutual learning does not develop as detached reflection but through practice, which simultaneously encompasses action and reflection. Users and designers work directly together in order to find common ground that encourages and enhances mutual understanding (Kensing & Greenbaum, 2013). Put differently, knowledge and ideas in PD develop continuously as a result of the interaction between users, designers and the particular context in which they engage.

Kensing and Munk-Madsen (1993) have identified three knowledge domains that should be established in PD projects: current practices, technological options and practices with new technology. First, *current practices* constitute the knowledge and experiences that users bring to the design process. Second, *technological options* refer to what designers experiment with and are knowledgeable about. Third, *practices with new technology* are the result of a mutual learning process and refer to ideas for future practices and how technology can support these (Kensing & Munk-Madsen, 1993). This balancing act or tension between current practices (what is) and future practices (what could be) forms the dialectical foundation of design.

Co-realization

The third and last principle, *co-realization*, refers to users taking an active part in visualizing and prototyping ideas and in learning about the qualities of the ideas in use or use-like settings (Bratteteig et al., 2013). This is an iterative process that requires continual participation and reflection on the designed artefact and the design process in general (Spinuzzi, 2005).

To this end, many tools and techniques have been developed, all with the same goal of enabling users to express their needs and visions for the future (Kensing & Greenbaum, 2013). By creating tangible artefacts (e.g. through paper prototyping), it becomes easier to understand the use context and technological possibilities and to imagine the consequences of a design suggestion. This relates to Bratteteig's and Wagner's

(2012) argument that, in order to avoid model monopoly and expand the universe of discourse, users should not be forced to adopt any abstract or formal language in order to participate in the design process (Bratteteig & Wagner, 2012). For instance, if users had to speak a technical programming language to get their voices heard, they would have to adopt the perspective or model within that language. This would limit their ability to express alternative visions and, hence, limit their decision-making power.

Ideally, co-realization takes place in a hybrid, third space that belongs neither to the domain of the users, nor to that of the designers. Muller (2002) describes PD as a border region between these two domains or spaces. This border region is characterized by *hybridity* and contains unpredictable and changing combinations of attributes of both domains. The practices that happen within this third space are uncertain and ambiguous in nature, but they provide fruitful ground for mutual learning between users and designers (Muller, 2002). In sum, co-realization serves a dual purpose: understanding the contextual conditions for design and exploring opportunities for change.

Case Study

WOOPI Project

The WOOPI case study presents an interdisciplinary project in which academia and industry partners collaborated to design a scalable framework for the development of Internet of Toys applications that incorporate physical, tradable, personalized cards and toys in an interactive multi-platform media experience. The academic partners included social scientists and human–computer interaction (HCI) researchers, as well as technical research partners. The industrial partners included a manufacturer of cards and games, a commercial media company, the national public broadcaster and a start-up company specialized in the creation of platforms for 3D printing and the customization tools.

Over the course of the project (ca. 18 months), a PD and research process was followed, including four main stages: (1) exploration of the problem space, (2) generating user insights, (3) concept definition and evaluation, and (4) iterative prototype development. At the end of the first three stages, development weeks were organized in which the project team gathered to share insights, brainstorm ideas, develop prototypes and boost decision-making.

Design and User Research Process

The four stages of the design and research process are discussed from the perspective of the authors (HCI researchers and social scientists), who were responsible for the user research and served as intermediaries for the academic and industry partners involved in the WOOPI project.

Exploring the Problem Space

To explore the problem space, the authors conducted conceptual, empirical and technical investigations (Friedman, Kahn, & Borning, 2008) that focused primarily on adults (i.e. parents, grandparents and teachers) as indirect stakeholders in the design of connected toys for young children.

First, a *conceptual investigation* was conducted by means of a literature study. The aim was to better understand the users and the values they might hold. Research was examined that focused on parents' perceptions of play and parental involvement in shaping young children's (4–6 years) facilitated play. This conceptual investigation resulted in two main research questions that were addressed in the empirical and technical investigations. The first question relates to parents' play beliefs and how connected toys may support or hinder these beliefs. The second question relates to parents' mediation practices regarding play and how connected toys may shape parents' involvement with children during play (Bleumers et al., 2015).

Second, an *empirical investigation* was conducted that served to complement findings from the literature. A survey was conducted that was directed towards parents with one or more children between the ages of four and six. The survey addressed digital media usage, children's play practices and parents' attitudes towards and mediation of those practices. A total of 2177 parents participated in the online survey, which resulted in 1398 completed entries. The survey results provided insights into the sociocultural context of connected toys (Bleumers et al., 2015).

Third, a *technical investigation* was conducted to assess how connected toys could support particular play beliefs and forms of parental involvement. Online customer reviews of connected toys and games for children were analysed. In such reviews, the properties of connected toys are described from the perspective of adults based on their experiences with these products. The reviews were coded bottom-up, resulting in descriptive codes for the actors involved, aspects of children's play and types of intergenerational play. In total, 270 reviews for 27 different products were analysed (for more details, see Bleumers et al., 2015).

The results of the conceptual, empirical and technical investigations were presented to the project partners at the start of the first development week. This was done in an interactive and informal way. For example, a quiz was organized to communicate the survey results, which resulted in lively debates among the project partners. During the second day of the development week, brainstorm sessions with design students, teachers and parents were organized. The leading questions stemmed from the conceptual investigations. For instance, in one such workshop, the participants were asked to brainstorm ideas for connected toys that would facilitate co-play between children, siblings, parents and/or teachers. At the end of the workshops, all participants gathered to present their ideas and paper prototypes to the project consortium. For the remainder of the week, the project partners selected ideas that were considered to be both novel and feasible, and they decided to further explore two use-case scenarios.

The first use-case scenario focused on the home context, proposing a hybrid gaming environment for young children consisting of physical objects (e.g. a card deck) that can communicate with a tablet application. Through a companion app, adults are allowed to play an active role in children's experience. The second use-case scenario focused on the school context. Building on the same platform as the application for the home context, schools can add educational content. A companion app for teachers allows them to modify the content and follow children's progress. The aim of the educational use case is to improve children's technical skills, collaboration and creativity.

Generating Contextual User Insights

After exploring the problem space and defining a point of view in the form of two use-case scenarios, in-depth user research was conducted to gain insights into contexts of use for both scenarios: the home environment and kindergarten. This user research consisted of a brief questionnaire, observations and semi-structured interviews with 8 teachers from 4 schools and 11 parents with preschool-aged children.

Upon arrival in the school, the researcher first informed the teacher about the research and asked for his/her written consent. Then, the teacher filled out a form with questions about children's digital media usage in class, the teacher's attitudes towards digital media and the teacher's digital skills and how they acquired these skills. Afterwards, a two-hour observation was conducted in the classroom. Focus points during the observation were toy preferences, types of play, the role of play in the class activities and the teacher's mediation practices. Next, a semi-structured interview was conducted in which the researcher asked about the meaning and role of play in the classroom, the types of (connected) toys that are used and the teacher's personal preferences, the perceived learning gains of play, the influence of play practices at home on children's behaviour in class, the role of the teacher in play practices (e.g. supervision, co-play, assistance) and the extent to which the personal vision of the teacher aligns with the vision of the school board.

A similar structure was applied for user research in the home environment. First, the parent was informed about the research and gave his/her written consent. Then, they filled out a form with questions about the child's use of digital media, their attitudes towards digital media and their skills. Next, the researcher asked the child to show his/her favourite toys and asked some clarifying questions (e.g. why is this your favourite toy?). Afterwards, a semi-structured interview was conducted with the parent in the presence of the child. The topics were similar to those of the interviews with teachers, focusing on the parent's play beliefs and mediation practices in the home environment.

The qualitative interview data were coded bottom-up and triangulated with the data from the questionnaires and observations. The user research resulted in a profound understanding of both usage contexts and the current role of (connected) toys within these contexts.

During the second development week, the results were presented and discussed with the project partners in a workshop format. Afterwards, a brainstorm session was conducted with the partners resulting in three main ideas for connected toys. Three multidisciplinary teams were composed, with each team focusing on further development of one of the main ideas for the remainder of the week. At the end of the week, each team presented their paper or low-tech prototype to the other teams.

The first concept is a high-tech bracelet for children that connect to an application on smart devices. The bracelet can be personalized by small, tradable and printable 'pins' that have an effect on the game narrative and the (educational or entertainment) content in the application. The bracelet also includes a digital passport that can be linked to other applications and safely stores individual (progress) information.

The second concept presents a collection of connected objects, including a personalized 3D-printed figurine, a themed card deck and a tablet application. In the application, there is a special module that allows children to personalize a figurine or create their own and have it 3D printed and sent to their home. This figurine connects with the application and facilitates 2-way communication between physical cards and the smart device. Depending on the card deck, children can interact with either educational or entertainment content.

The third concept is a robot that interacts with other objects, including physical cards. Children can program the robot's behaviour (e.g. how it moves) via an application on a smart device or by tapping it with physical cards that connect with the robot. When the robot is used to play one of the (entertainment or educational) games initiated with the application, a LED display provides feedback. The robot can also be customized (e.g. with Lego bricks or 3D printed shells).

Concept Definition and Evaluation

After the second development week, the three concepts were further refined and a formative evaluation was conducted with the same kindergarten teachers and parents who were involved in the previous stage. The three concepts were explained by means of storyboards (see Fig. 9.1). After discussing the teacher's or parent's overall impression, the researcher asked them to pick one concept and, by means of open questions, tried to reveal the underlying motives for this choice (cf. laddering interview technique).

First, the parent or teacher was asked to clarify which aspects or properties of the selected concept stood out compared to other concepts. Each property was written on a separate sticky note, and, when a large number of properties emerged, they were prioritized before moving on to the next step. In the second step, the perceived consequences of each property were discussed in detail. The teacher or parent explained why that property is important and how it may contribute to children's play experience. Then, in the third step, the researcher asked why this perceived consequence is considered important for the child, and how it relates to the teacher's or parent's personal values. To wrap up the

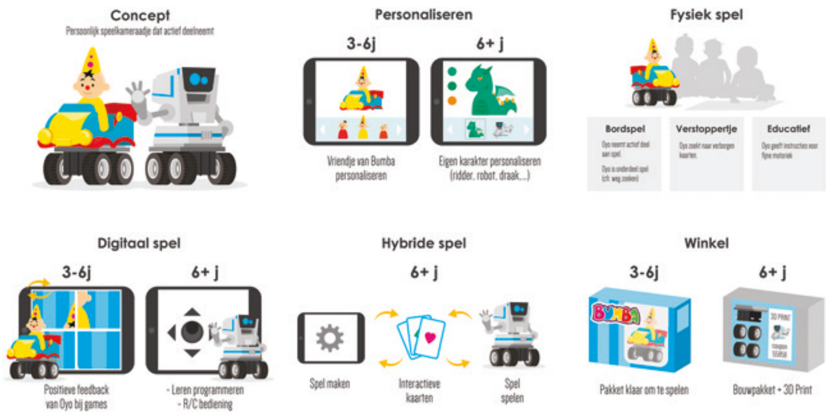

Fig. 9.1 Storyboard visualizing the third concept, a customizable robot that interacts with other objects, including physical cards

evaluation, the researcher asked what, if anything, the teacher or parent would like to change about the selected concept and why.

The feedback from eight teachers and 11 parents on the three concepts was thematically analysed and shared with the project consortium during the third development week. During this week, it was decided to further develop the robot concept and, for now, focus on the school context. The school context was considered most challenging in terms of facilitating co-play, mediation by adults, providing suitable content and durability. During the remainder of the week, the use-case scenario of the robot concept was elaborated based on the feedback from parents and teachers (stage 2), and high-tech prototyping was initiated. Furthermore, decisions were made about what had to be done by which partner in the final months of the project. The ultimate project goal was to deliver a workable demonstrator of a connected toy for the school environment.

Iterative Prototype Development

In stage four of the project, the selected concept was further developed into a high-tech prototype (see Fig. 9.2) consisting of a robot with an LED display and speaker that can move in different directions, a set of physical cards and a tablet application. All these objects can communicate with each other in two directions.

While the high-tech prototype was being developed, four gameplay scenarios for the robot were created: free play, memory, mastermind and storytelling. In the *free play* modus, children tap the robot with one of the cards and the robot immediately executes the behaviour indicated on the card (e.g. turning to the left, playing a tune, showing a smiley on the display). In the *storytelling* modus, children can program the robot's behaviour and save the sequence of steps on an empty card. The tablet application provides a visual overview of the programmed behaviour, which children can edit afterwards. In the *memory* modus, the robot does something (e.g. the LED display turns red, the robot moves one step forward) and children need to pick the corresponding card as quickly as possible and tap it on the robot, which provides feedback

Fig. 9.2 The final prototype that was evaluated by 266 children aged 4–6 years in eight schools

accordingly. In the *mastermind* modus, the robot executes four steps that children have to replicate by tapping the corresponding cards in the right order on the robot. Compared to the memory modus, speed is not a factor and the robot executes a sequence of steps instead of just one at a time.

When the high-tech prototype and game scenarios were finished, they were evaluated by 266 preschool children aged 4–6 years in eight schools. During each playtest, two researchers were present, one facilitator and one observer who did not intervene. Children played with the robot in small groups of 3–4 boys and girls. First, the facilitator explained the purpose of the evaluation and what was expected. Next, children played the different game scenarios, starting with the free play mode. Between modes, the children indicated whether they liked the game and if they wanted to play it again. To this end, a Smileyometer was used that consists of five smileys ranging from very sad through neutral to very happy. Children were asked to choose the smiley that resonated with their experience (see, Read & MacFarlane, 2006). In addition, we asked children to indicate which play modes they found the easiest and hardest and which play modes they found the most and least fun to play. After having evaluated each mode, the facilitator had a short conversation about children's favourite toys and games and wrapped up the session. Before the next group of children entered the room, the observer briefly discussed his/her notes with the facilitator and made adjustments where needed.

The observation notes and children's self-evaluations with the Smileyometer provided valuable insights into children's play experiences, the social interactions with peers and the adult facilitator during play, and the extent to which children created their own stories while interacting with the robot, the cards and the application. The results of the playtests were presented and discussed with the project consortium during a closing event and summarized in a report that describes the demonstrator application and indicates areas for improvement. The commercial partners could use these insights to finalize the prototype, develop other variants and, eventually, bring the connected toy(s) to market.

Discussion

The PD approach allowed the WOOPI project team to iteratively design connected toys in close collaboration with envisioned users (children) and those impacted by its use (parents and teachers), but adhering to PD's core principles proved to be challenging.

Revisiting the Core Principles

Having a Say

All major design decisions in the WOOPI project were informed by parents, teachers and, to a lesser extent, children. The degree to which they informed the decision-making process can be seen as a continuum ranging from *no* through *indirect* to *direct influence*. Taking all four stages of the design and research process into account, parents' and teachers' positions on this continuum are somewhere in the middle between indirect and direct influence, whereas the children's position is closer to indirect influence. Although users, including children, have the right to be heard in matters that affect their lives and environments, it was not always possible to achieve this in a straightforward manner.

Most design decisions were made by the project team during the development weeks, whereby the authors advocated the interests of the users. For instance, in the first development week, the project team decided to focus on two use-case scenarios informed by the conceptual, empirical and technical investigations. A similar rather indirect influence on the decision-making process could be witnessed in the second development week. The project team developed three concepts informed by the results of user research earlier conducted (i.e. observations and interviews), which set the future focus of the project. During the third development week, the project team selected the most promising concept based on feedback from parents and teachers. This concept was further developed into a high-end prototype and different gameplay scenarios that were evaluated on a large scale with children. Although children's play practices had informed the design process, it was not until this stage that they could voice their opinion about the design and exert a more direct influence. This was mainly due to a lack of available methods to design with children aged 6 and younger.

In sum, the ideal of directly involving users in *all* decisions proved difficult to achieve. Children's young ages and the time needed to negotiate differing interests among the project partners were the main reasons to choose more indirect methods to give users a *say*.

Mutual Learning

Mutual learning between designers and users occurred in different stages of the WOOPI project. For instance, during the first development week, brainstorm sessions were conducted with designers, parents and teachers that allowed for an exchange of expertise and ideas. A similar process could be witnessed in the third stage, when parents and teachers evaluated three design concepts. By means of storyboards, the concepts and the technology needed to realize them were explained. Afterwards, parents and teachers elaborated on what features they liked and disliked for their children, and what should be added or changed. Through this dialogue, new insights into the opportunities and risks of connected toys in the home and school context emerged.

Mutual learning also occurred in the fourth stage. Children experienced the possibilities of the high-end prototype first-hand, and, simultaneously, designers gained insights into children's interactions with the prototype and gameplay scenarios. Compared to the concept evaluation in the third stage, the learning did not happen through extensive dialogue. Since children's verbal skills are rather limited at ages 4–6 years, long conversations about the prototype and its potential impact on children's lives were avoided. Instead, careful observations were combined with short clarifying questions.

Mutual learning between designers and users did not happen in all stages. In stages 1 and 2, the learning was mainly one-directional. Designers gathered information about users via secondary research and by studying users' current practices. For instance, observing children in their homes and schools unravelled tacit knowledge about children's play practices and how they interact with peers and adults during play, but children did not yet learn anything from designers.

Finally, mutual learning also occurred between the designers (i.e. project partners), especially during the development weeks. During these week-long meetings, the project partners gathered in a design lab to share and discuss new insights and work on prototypes. This was challenging due to the multidisciplinary nature of the project team and the difficulty of bridging various expertises and conflicting interests. However, by engaging in hands-on activities, the meetings resulted in new insights that were materialized in design concepts, storyboards and high-end prototypes.

Co-realization

Whereas parents, teachers and children informed the design process in all four project stages of the WOOPI project, they hardly participated in visualizing ideas and making prototypes. One exception was the brainstorm activities in the first development week in which designers collaborated with parents and teachers. In most cases, though, conventional user-study methods such as interviews and observations were used. For instance, in stage 3, parents and teachers evaluated three design concepts that were presented as storyboards. Although they were invited to voice their opinions on these early designs, this happened in a verbal manner. No generative or *making* activities were added in which designers and users (in this case parents and teachers) co-realized connected toys.

A similar situation could be witnessed in stage 4 when children evaluated a high-end prototype. Children were observed while playing with the connected toy, but they could not modify or appropriate it to their own preferences. As mentioned earlier, a lack of research on PD with young children was the main rationale for not initiating generative design activities. In future work, it would be worthwhile to see if *making* techniques used for older children are suitable for design projects with 4–6-year-olds (see, e.g., Van Mechelen, 2016).

Co-realization was mainly achieved during the three development weeks in which the project partners, each with their own expertise, engaged in *making* activities. During the week-long meetings, they shared research results in workshop-like settings, brainstormed ideas on sticky notes, sketched storyboards and developed prototypes with low-tech materials that were tested in use-like settings and modified afterwards.

These hands-on activities with easy-to-use materials established a common language that all project partners understood. Muller (2002) has referred to this process as the enactment of a *third space*, i.e. a border region between the knowledge domains of participants with different backgrounds. In the first development week, these activities resulted in two use-case scenarios for connected toys. During the second development week, three design concepts were realized; and in the third week, the most promising concept was developed into a high-tech prototype. In sum, all project partners actively participated in realizing the design.

Guidelines to Increase Participation

Despite the authors' best intentions, adhering to PD's core principles in the design of connected toys was a challenging endeavour. Differing interests among the project partners, the target group's young age (4–6 years) and a tight schedule were among the most important barriers. However, looking at the principles as desired ends on three continuums helped the authors in preparing, conducting and reflecting on the PD activities.

Based on the lessons learned in the WOOPI project, six guidelines were formulated for adhering to PD's core principles and increasing users' participation in the design of connected toys. These guidelines are by no means exhaustive, and, when applying them, the context in which they were developed should be carefully considered. The guidelines are as follows:

- To expand the universe of discourse, involve a broad range of stakeholders in the design process, including those who are indirectly impacted by the use of the technology and the project partners. Think of a strategy for involving users, including children, early on and continuously in the design process.
- Instead of a fixed goal or research question, use an open-ended problem statement grounded in use practices as a starting point for design. Often, the solution that is being developed and the initial problem statement mutually influence each other as the design process unfolds. Allow for such flexibility.
- Establish an atmosphere of trust and openness towards each stakeholder's expertise. Broadly speaking, there are two knowledge domains at the start: (1) the current practices of the user, including tacit knowledge that is often hard to express in words, and (2) knowledge about the design process and technological possibilities.
- Avoid a one-directional learning process when engaging with users. Instead, explore the design space together and co-determine the agenda. This allows for mutual learning and the emergence of a third hybrid knowledge domain that belongs neither to the users, nor to the designers: (3) future practices mediated by technology.

- Engage users in *making* things. Jointly visualizing and prototyping ideas make it easier to understand current practices and technological possibilities. Moreover, it helps to imagine the consequences of the design suggestions and creates a common language that all participants can understand.
- Whenever possible, show users, and in particular children, what decisions go into the development of technology. Make them realize that they do have a choice with regard to the use of new technology and raise critical awareness about how such technology may influence their lives and environments.

Conclusion

This chapter provided methodological insights of how Internet of Toys applications can be designed together with children as well as other relevant stakeholders such as parents and teachers. Richly illustrated by a case study (i.e. the WOOPI project), it was shown how technological and social demands can be reconciled in the design of connected toys. In this process, the team jointly and creatively explored the design space, iteratively developing knowledge about current practices (what is) and ideas for future practices mediated by connected toys (what could be).

In line with PD's core principles (sharing decision-making power, mutual learning and co-realization), continuous reflection and participation of multiple stakeholders, including children, were aimed for. As for the first principle, *having a say*, children's decision-making power was rather limited, because the design problem was defined upfront, and all major design decisions were made by the project team. In terms of *mutual learning*, the second principle, the project team learned about the viewpoints of children, parents and teachers and gained profound insights into two envisioned use contexts: home and school. Children, parents and teachers, in turn, learned about the possibilities of the Internet of Things, and how this technology, in the form of toys, can be implemented in schools and at home. *Co-realization*, the third principle, was achieved via design sprints during three development weeks with the project partners. Children did not participate in these design sprints but evaluated the prototypes and gameplay scenarios afterwards in real-life settings.

Overall, parents and teachers were more systematically involved than children, both through conventional user-study methods (e.g. interviews) and more hands-on methods (e.g. brainstorming sessions). To better adhere to PD's core principles and further strengthen children's participation in the design process, the guidelines presented in the discussion section provide a useful starting point. In line with the Convention on the Rights of the Child (United Nations, 1989), these guidelines are a step forward in giving children *a say* in all matters affecting their lives and environments.

Acknowledgements This study was part of WOOPI (http://bit.ly/1F24wRO), a cooperative-PLUS project facilitated by (former) iMinds Media and funded by the IWT for participating companies. Ethical clearance from the ethics committee (SMEC, KU Leuven) was obtained during the project. The authors are grateful to the project partners and the children, parents and teachers who participated in the research and design activities.

Notes

1. In this chapter, the term 'users' refers to the envisioned end-users of technology, and those who are directly or indirectly impacted by its use.
2. In this chapter, the term 'designers' refers to the whole project team, including designers, researchers, developers and industry partners.

References

Bleumers, L., Mouws, K., Huyghe, J., Van Mechelen, M., Mariën, I., & Zaman, B. (2015). Sensitivity to parental play beliefs and mediation in young children's hybrid play activities. In *Proceedings of the 14th International Conference on Interaction Design and Children* (pp. 170–177). New York: ACM.

Braten, S. (1973). Model monopoly and communication: Systems theoretical notes on democratisation. *Acta Sociologica, 16,* 98–107.

Bratteteig, T., Bodker, K., Dittrich, Y., Holst, P., & Simonsen, J. (2013). Methods: Organising principles and general guidelines for participatory design projects. In *Routledge International Handbook of Participatory Design*. Oxford: Routledge.

Bratteteig, T., & Wagner, I. (2012). Disentangling power and decision-making in participatory design. In *Proceedings of the 12th Participatory Design Conference: Research Papers—Volume 1* (pp. 41–50). New York: ACM.

Clement, A. (1994). Computing at work: Empowering action by "low-level" users. *Communications of the ACM, 37*(1), 52–63.

Donoso, V., Verdoodt, V., Van Mechelen, M., & Jasmontaite, L. (2016). Faraway so close: Why the digital industry needs scholars and the other way around. *Journal of Children and Media, 10*(2), 200–207.

Ehn, P. (1993). Scandinavian design: On participation and skill. In D. Schuler & A. Namioka (Eds.), *Participatory design—Principles and practices* (pp. 41–70). Hillsdale: Lawrence Erlbaum Associates.

Frauenberger, C., Good, J., Fitzpatrick, G., & Iversen, O. S. (2015). In pursuit of rigour and accountability in participatory design. *International Journal of Human-Computer Studies, 74,* 93–106.

Friedman, B., Kahn, P. H., & Borning, A. (2008). Value sensitive design and information systems. In K. E. Himma & H. T. Tavani (Eds.), *The handbook of information and computer ethics* (pp. 69–101). Hoboken: Wiley.

Kensing, F., & Greenbaum, J. (2013). Heritage: Having a say. In J. Simonsen & T. Robertson (Eds.), *Routledge international handbook of participatory design*. Oxford: Routledge.

Kensing, F., & Munk-Madsen, A. (1993). PD: Structure in the toolbox. *Communications ACM, 36*(6), 78–85.

Livingstone, S., & Third, A. (2017). Children and young people's rights in the digital age: An emerging agenda. *New Media & Society, 19*(5), 657–670.

McReynolds, E., Hubbard, S., Lau, T., Saraf, A., Cakmak, M., & Roesner, F. (2017). Toys that listen: A study of parents, children, and internet-connected toys. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (pp. 5197–5207). New York: ACM.

Muller, M. J. (2002). Participatory design: The third space in HCI. In J. A. Jacko & A. Sears (Eds.), *The human–computer interaction handbook* (pp. 1051–1068). Hillsdale: L. Erlbaum Associates.

Polanyi, M. (1983). *The tacit dimension*. Gloucester: Peter Smith.

Read, J. C., & MacFarlane, S. (2006). Using the fun toolkit and other survey methods to gather opinions in child computer interaction. In *Proceedings of the 2006 Conference on Interaction Design and Children* (pp. 81–88). New York: ACM.

Robertson, T., & Simonsen, J. (2013). Participatory design: An introduction. In J. Simonsen & T. Robertson (Eds.), *Routledge international handbook of participatory design*. Oxford: Routledge.

Schön, D. A. (1983). *The reflective practitioner: How professionals think in action* (1st ed.). New York: Basic Books.

Schuler, D., & Namioka, A. (Eds.). (1993). *Participatory design: Principles and practices*. Hillsdale, NY: L. Erlbaum Associates.

Spinuzzi, C. (2005). The methodology of participatory design. *Technical Communication, 52*(2), 163–174.

United Nations. (1989). *Convention on the rights of the child*. United Nations. Retrieved from http://www2.ohchr.org/english/law/crc.htm.

Van Mechelen, M. (2016). *Designing technologies for and with children: Theoretical reflections and a practical inquiry towards a co-design toolkit*. Doctoral thesis defended in June 2016, UHasselt—KU Leuven. Retrieved from https://bit.ly/2tDS0te.

Winograd, T., & Flores, F. (1986). *Understanding computers and cognition*. New York: Addison-Wesley.

Zaman, B., Van Mechelen, M., & Bleumers, L. (2018). When toys come to life: Considering the internet of toys from an animistic design perspective. In *Proceedings of the 17th ACM Conference on Interaction Design and Children* (pp. 170–180). New York: ACM.