Co-creating hybrid toys as an approach to understand children's needs in play experience

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Abstract

Using hybrid toys to deliver physical therapy is an innovative way to engage children in personalized healthcare. However, there is an urgency to understand children's needs in their digital-physical play experience, to effectively design these toys. The aims of this explorative study were to identify the needs of children in their play experience, and to examine co-creation workshops as a mean to do that. Ten children and thirteen observers participated. Participants were asked to reflect on what they like most about play, while building a hybrid toy and discussing the rationale behind their actions. The statements were written down by the observers and analysed via concept mapping and network analysis to categorize them. Finally, the children filled in a questionnaire after the session to assess the acceptance of the workshop. We have found that the identified needs can refer to different aspects from psychological to practical functionality, providing a wide panorama of requirements. The results of the questionnaire show that children enjoyed the topic,

the use of technology and the process of co-creation. The combination of co-creation with concept mapping allows us to collect and categorize the identified needs to further develop future designs.

Keywords: Hybrid toys, Play, Motivation, Co-creation, Prototyping.

1. Introduction

Physical and occupational therapy can make important contributions to improving people's wellbeing, however despite efforts to make therapies engaging (Aarts et al., 2012), patients often find them challenging and uninviting due to their repetitiveness. The rise of emerging technologies, including hybrid toys, gives therapists the opportunity to explore other tools that can be used in assessments and intervention sessions. Eventually, the use of such tools could benefit patients because they could allow for more personalized therapies and improve patient engagement. Throughout this chapter, the terms 'hybrid toy' or 'hybrid play' will refer to the combination of physical and digital elements in toys or play experience. This combination provides new opportunities for play, by adding feedback, automatization or data collection. Extensive research has shown the importance of play in the development of children (Piaget, 1945; Vygotsky, 1967) and user-centred design's relevance in creating better products (Sanders & Stappers, 2008). Although co-creation, as an approach of user-centred design, has been widely studied, and hybrid toys have been studied to some extent (Tyni et al., 2016), few studies have investigated co-creation of hybrid toys as a way to understand the user's needs.

The study presented in this chapter analyses the impact of prototyping hybrid toys during a co-creation workshop, intended for children 7-12 years old. The research questions addressed are (1) which needs do children have in their hybrid play experience in terms of interactions, topics and type of play and (2) can we better understand those needs by co-creating hybrid toys with them. To answer our first question, data was gathered and analysed via concept mapping, a method that has previously been used to determine users' requirements (Ogden, Barr, & Greenfield, 2017). To gain deeper insight into the results of concept mapping we used network analysis. Furthermore, to answer the second research question we used a questionnaire, as it is standard in collecting participants' feedback (Alreck & Settle, 1994). Understanding children's needs in their hybrid play experience will help designers create new toys with applications in fields such as health, while empowering children in their use of technologies. In this study we have identified different aspects of children's play experience with hybrid toys such as: psychological needs, practical functionality, opinions and requirements.

2. Hybrid toys and understanding the user

2.1 Play objects and technology

Play is a fundamental part of children's development as it helps them discover the world while developing skills, identity and self-esteem. Despite there being different definitions of play, for the remainder of this chapter, we will refer to 'play' as "the quality of mind during enjoyable, captivating, intrinsically motivated and process focused activities." (Kudrowitz & Wallace, 2009). Current generations of children are growing in a world where technology is ubiquitous. From mobile phones, smart televisions and robot vacuum cleaners to home assistants, children today are surrounded by a diversity of devices. It is only natural that their play experience is becoming more linked to these new technologies. Recently, the diversity and sophistication of toys that include electronics has increased, to those we refer as hybrid toys. These are understood as play objects that have a mixture of physical and digital components (Tyni et al., 2016), using software, sensors, and actuators is common and they may or may not connect to the internet or other devices (Mascheroni & Holloway, 2017). Related terms are: smart-toys, connected toys, internet of toys and augmented toys. These toys have been gaining popularity as younger generations find the borders between the physical and digital less obvious and their familiarity with technology is more natural. They can provide immediate and diverse feedback, data collection, interactivity and personalized behaviour. Examples of hybrid toys are: care toys such as Tamagotchi and Hatchimals, educational toys that help children learn to program like Doc Clementoni and GoTo drawing machine, and advance action figures that expand the video game experience like Amiibo (Figure 1).

Figure 1 Examples of hybrid toys: Tamagotchi (https://www.bandai.com/original-tamagotchi/), Hatchimals (http://www.hatchimals.com), Doc Clementoni (https://www.clementoni.com/en/61323-doc-interactive-talking-robot/), GoTo (https://www.studiotast.com/goto) and Amiibo (https://www.nintendo.com/amiibo/)

Besides being used for recreation, hybrid toys are starting to be used in education and health. In their review of "Smart Toy based learning" (2014), Cagiltay, Kara & Aydin present an analysis of hybrid toys in education. According to these authors, hybrid toys become cognitive tools by providing interactive learning experiences. They are used to teach mathematics, coding, languages, cultural values (Al-Khalifa et al., 2018), music (Luo et al, 2018), communication skills, creativity and social interaction (Ihamäki & Heljakka, 2018) to name a few fields. In the health domain, adding sensors in toys, and the possibility to record and store data have likewise opened new opportunities. Smart toys could be (and to some extent already are) used for therapies, sports and assessment of cognitive and motor skills. In this domain, researchers have for example developed toys that encourage social interaction for children with autism (Farr, Yuill, & Hinske, 2012), toys that detect delays in motor skill development (Mironcika et al., 2018; Sander et al., 2017) and toys and games that promote movement (Levac et al., 2010) Although potential uses of these toys have been described in literature, there are limited studies with emphasis on children's perception and preferences in hybrid toys and how technology is affecting their play experience.

2.2 Understanding the user

Co-creation is a design practice where the user is considered the expert, and is asked to take an active participation in the design process (Sanders & Stappers, 2008). It is used by designers as a methodology to better understand users and their needs. The importance of involving users in earlier levels of this process relates to the needs of relevance, perspective and ownership (Plattner, Meinel, & Leifer, 2012) towards the object or system to be designed. Previous studies have used this approach to design character toys (Ihamäki & Heljakka, 2017) and learning environments (Kangas, 2010). Other examples are Game Jams, which are events that provide educational value for participants, while generating new knowledge by creating prototypes of games or video games in a short amount of time (Deen et al., 2014). With this in mind, we designed a co-creation session where children could build hybrid toys in a space open for experimentation and discussions.

3. Methodology

3.1 Co-creation

The co-creation workshop "Digital & Physical Play – Digital Camp" took place at the Amsterdam University of Applied Sciences and at the Public Library of Amsterdam, on the 16th and 17th of November 2018. Ten adults and nine children participated. We asked the participating children to reflect on what they like most about play, which themes or topics they are interested in, what type of features they like in toys and how they would use technology. This was done by building a prototype and discussing the rationale behind their actions following a design thinking process (Plattner et al., 2012). This process was structured in five main steps:

1. Empathize – Understand the design challenges. This involves empathizing with the user, understanding the needs and the ecosystem around the activity. Participants were asked to create a Persona of their intended user as a way to understand and empathize with the target audience.
2. Define – Summarize requirements of the design, what does it need to have/do to be able to suit the user(s). Participants were asked to reflect on the needs and desires of their persona as a way to extract insights and design criteria.

3. Ideate – Use the defined criteria to come up with ideas and concepts that fit the users. Participants were asked to do brainstorming using lotus blossom (Vangundy, 2004), and pick the concept that best fit their design criteria.
4. Prototype – Build a prototype of the most promising design concept(s). Participants were asked to build high-fidelity prototypes of their concepts.
5. Test – Test the prototype with users. Participants tested their high-fidelity prototypes with their target audience.

Data was collected from the session, and explored via concept mapping and network analysis. Finally, we used a questionnaire to analyse the acceptance of the co-creation process.

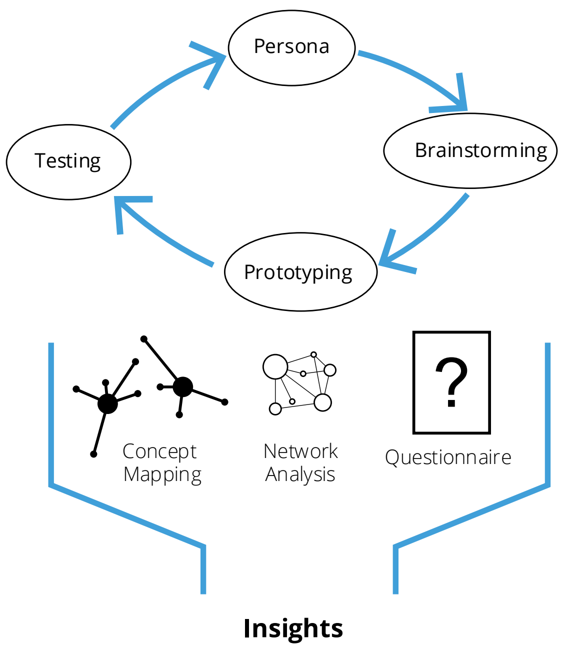

Figure 2 Co-creation cycle used in the workshop

3.2 Concept mapping

Concept mapping is a structured process that is focused on a topic or problem that needs to be solved (

Figure *3*). It involves input from several parties, which produces a graphical view (concept map) of their ideas and concepts. It allows participants to easily visualize how these ideas (statements) are interrelated and how they can be clustered

(Trochim, 1989). There are six main steps that Trochim defines as part of this process:

1. Prepare project, by choosing a focus, recruiting participants and scheduling the mapping.
2. Generate ideas, where participants will formulate statements that answer the seeding question.
3. Structure ideas, where the previously mentioned statements or ideas will be organized by the participants in clusters.
4. Compute maps, statistical analysis done on the clusters of ideas generated. For this study we used the open source tool R-CMap (Bar & Mentch, 2017) to aid us generate this analysis.
5. Interpret maps: where stakeholders and researchers analyse and interpret the maps.
6. Utilize maps: bring the results into practice, which in our case will be developing new hybrid toys.

We used concept mapping to get an overview of the main clusters that were identified within the statements. Additionally, we wanted to have an overview of the entire network and see how the different statements related to each other; for that we used network analysis.

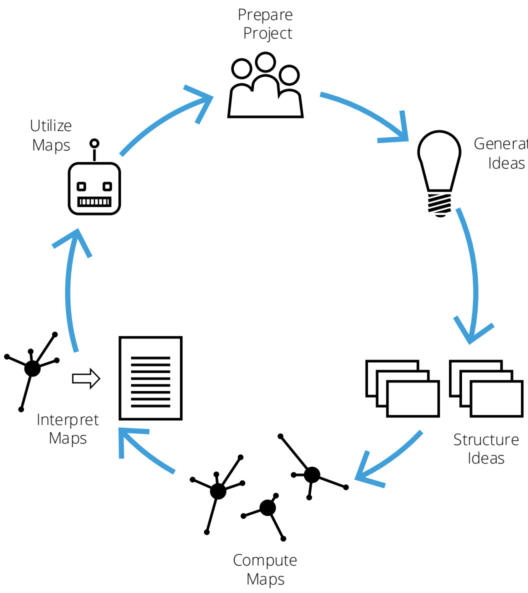

Figure 3 Concept mapping structure

3.3 Network Analysis

Network analysis is a method that allows examining the relationships between nodes (statements) and edges (relationships that connect them). This uncovers the relationship, closeness and clusters of similarity that nodes have within networks (Borgatti, Mehra, Brass, & Labianca, 2019), and an overview of the connections between the different nodes. Network analysis was used to help identify the similarity and links between the network of statements made by the participants of the session.

3.4 Questionnaire

A questionnaire was filled in by nine of the ten children that participated once the co-creation session ended (one of the participants had to leave early). The questionnaire consisted of open questions and Likert scale questions asking about the children's perception of the co-creation session, their use of technologies their creativity and further interest in the topic of the workshop.

3.5 Study

We designed and conducted an exploratory workshop of co-creating hybrid toys, where children worked together with adult participants in creating a prototype. In this section we will describe the materials, participants and structure of the workshop.

Materials: Participants could use a variety of electronic tools: Nintendo Switch with their programmable interface provided by Nintendo Labo, LittleBits a collection of electronic building blocks, Makey Makey an interface that replaces the keyboard with the use of conductive material, and the Touch Board a microcontroller that can play sounds via the use of electrodes. Participants also had access to Legos, craft material and a laser cutter.

Day 1: Nine design students and design/game professionals (7 females, 2 males; age-range: 24-42y) participated in a workshop. After reviewing theory about the importance of play and different types and characteristics of hybrid toys (Tyni et al., 2016), participants worked in teams of three to create a prototype of a toy with physical and digital elements. They started by defining a persona, then participants used Lotus blossom for ideation, the result of this process was three different prototypes of hybrid toys. These hybrid toys were used in day two as thought-provoking tools (Figure 4).

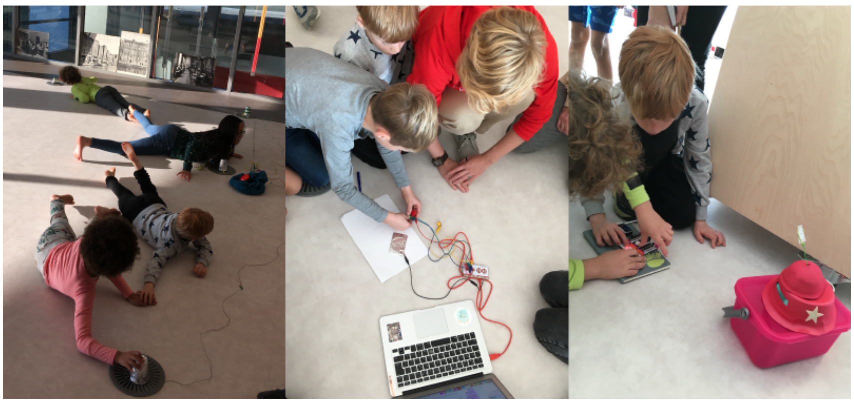

Figure 4 Children playing with the prototypes created by the observers during Day 1

Day 2: Ten children (7 boys, 3 girls; age-range 7-12y) were invited to participate as “experts of play”. With consent from the children’s parents, video and photographs were taken. The children first tested the prototypes created by the observers during the first day of the workshop in order to get them into a playful mood, get comfortable as a group and collect feedback from their play experience. They were divided into teams (one of four and two of three participants) supported by observers (adult participants and coaches) to create their own prototype of a hybrid toy. The role of the observers included taking note of behaviours and comments of the children. Coaches had experience with the tools provided and helped troubleshoot issues. A brainstorming session (Figure 5) helped children identify themes and objects that they found interesting and decide which play object they were going to build. During the prototyping session they experimented with the tools provided, thought about which type of actions they wanted their toys to perform, and made a sketch of what they wanted to build. As result of this session each team built a hybrid toy: “Monster car”, “Horror House” and “The roller coaster” (Figure 6). At the end there was a round of testing and feedback. All of their remarks during this process were recorded by the observers as statements.

Figure 5 Some ideas from the brainstorming session

Figure 6 Prototypes day 2: Monster car, Horror house and Roller coaster

In Concept Mapping ideas are generated based on a seeding question, for this research the seeding question was: *"Which characteristics of hybrid toys and play experience motivate children to play?"*. During the workshop observers wrote down statements that answered the question and during a closing session they compiled a final list of statements, based on what the children said. This list was later verified with video and audio recordings from the day. To generate a concept mapping analysis, observers clustered statements based on similarity and rated their importance (based on children's behaviour and comments) on a Likert scale (1 to 5) by using a digital tool (Figure 7) (Brons, 2018).

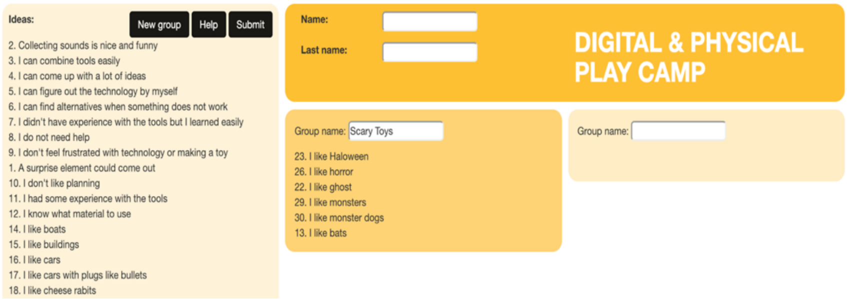

Figure 7 Clustering tool

4. Results

The observers (n=13; 8 students/design professionals and 5 coaches) identified 81 statements, six of them clustered the statements answering the seeding question. By using concept mapping, we clustered those 81 statements into 8 clusters (Table 1).

Curiosity and freedom		**DIY technology**	
3	I can combine tools easily	25	I like high technology vehicles
4	I can come up with a lot of ideas	34	I like robots
5	I can figure out the technology by myself	35	I like scary
6	I can find alternatives when something does not work	43	I like to do crafts
7	I didn't have experience with the tools but I learned easily	**Technology variety**	
8	I do not need help	32	I like Nintendo Switch
9	I don't feel frustrated with technology or making a toy	39	I like technology
12	I know what material to use	50	I like to see a personalized message
21	I like free play	51	I like to use digital tools
41	I like to be part of participatory design	55	I like videogames
42	I like to be relaxed	57	I liked the birthday cake toy
44	I like to explore	63	I want electricity
45	I like to feel curious	76	LitteBits is just another block
46	I like to have instructions at the beginning but play freely after.	**Themes for toys**	

47	I like to make different combinations
52	I like to use my imagination
Hybrid functionality	
1	A surprise element could come out
65	I want to combine the digital and physical worlds
69	I want to know which musical instruments are used
74	It is not necessary to add digital
How to play	
10	I don't like planning
19	I like destruction
40	I like to be competitive
48	I like to play with lego freely, without instructions.
56	I like when a game is exciting
73	It is nice to play together
77	Making a toy is playing
80	The game could have an specific environment
Game structure	
11	I had some experience with the tools
27	I like lego
49	I like to play outside
64	I want to build a tomato charger to a phone
68	I want to know which action triggers a sound
72	It is funny to be barefoot
79	The game could be played in the dark
Feedback signal	
2	Collecting sounds is nice and funny
58	I missed the use of sounds
66	I want to have variety of sounds
67	I want to hear other sounds

13	I like bats
14	I like boats
15	I like buildings
16	I like cars
17	I like cars with plugs like bullets
18	I like cheese rabits
20	I like dogs
22	I like ghost
23	I like Halloween
24	I like helicopters
26	I like horror
28	I like light
29	I like monsters
30	I like monster dogs
31	I like monster tanks
33	I like remote control cars
36	I like snakes
37	I like spiders
38	I like tanks
53	I like trucks
54	I like vampires
59	I want a house that walks
60	I want a robot house
61	I want a roller coaster
62	I want animals

70	I want to see more emojis
71	It could use a secret language
75	It is super cool to send and receive a signal
78	More messages could be sent
81	The use of remote control is fun

Table 1 Clustered statements

The dendogram plot (Figure 8) and the ray cluster map (Figure 9) show the clustered statements. Table 2 shows that the cluster "Curiosity and freedom" scored highest on importance. This cluster shows that children enjoyed combining tools easily, explore, feel curious and have free play as a component of their play activity. This gives indications of the importance of open play as a format for toys. In the second highest scoring cluster: "Hybrid functionality", the contradictory statements "I want to combine the digital and physical world" and "it is not necessary to add digital", show that the addition of digital elements needs to be meaningful. As Goldstein (2012 p. 29) has stated "If a toy is no fun to play with, no amount of technology will increase its desirability as a play object". The "Feedback signal" cluster highlights the importance of sound as a part of the toy. The "Technology variety" cluster shows the acceptance of the tools used in the workshop. In the "Themes for toys" cluster we see a list of topics that children enjoy in their play experience. The "How to play" and the "DIY technology" clusters provide diverse views of elements that can be part of the toys. Furthermore, what is noticed is that the statements identified relate to different needs: psychological needs, practical functionality, opinions and requirements, which encompass a wide range of users' needs.

Cluster ID	N	Mean	S D
Curiosity and freedom	16	3.92	0.47
Hybrid functionality	4	3.75	0.29
How to play	8	3.35	0.59
Game structure	7	2.90	0.79
Feedback signal	9	2.87	0.69
DIY technology	4	2.67	0.76
Technology variety	8	2.46	0.82
Themes for toys	25	1.73	0.31

Table 2 Summary of clusters

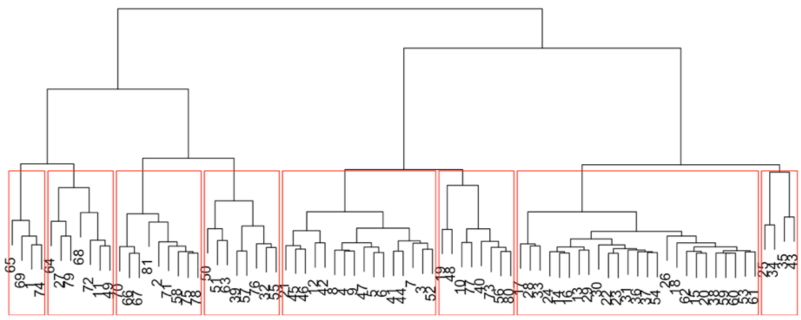

Figure 8 Dendogram plot

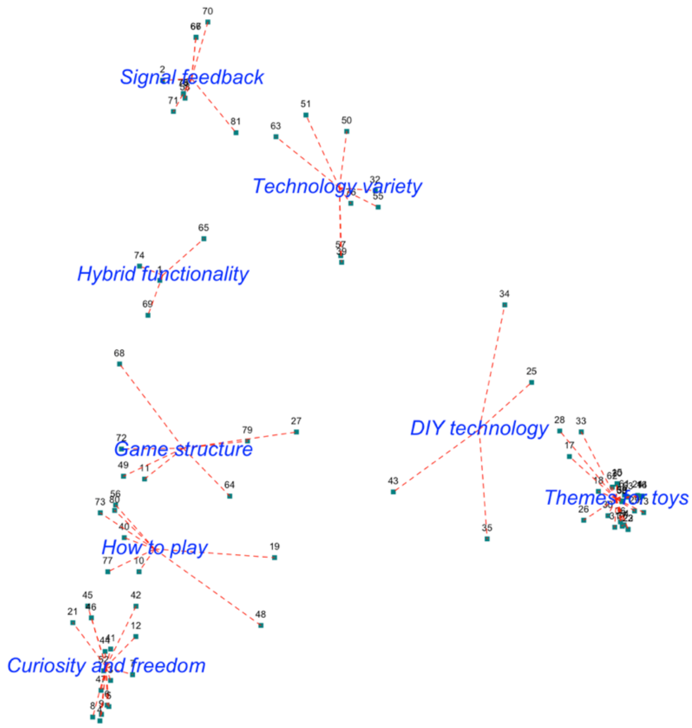

Figure 9 Ray cluster map

The network analysis of the statements (Figure 10) shows that there are two main clusters of information. The cluster on the right revolves around conceptual themes that the children would like their toys to have. The second cluster revolves around the activities that they find interesting/fun when playing. This second cluster is divided into two sub clusters that centre around expectations and desires that the children have about the physical characteristics of toys and the interaction expectations and desires about play itself. In the middle of both clusters is a sub-cluster that revolves around what the children find important when making their own toys.

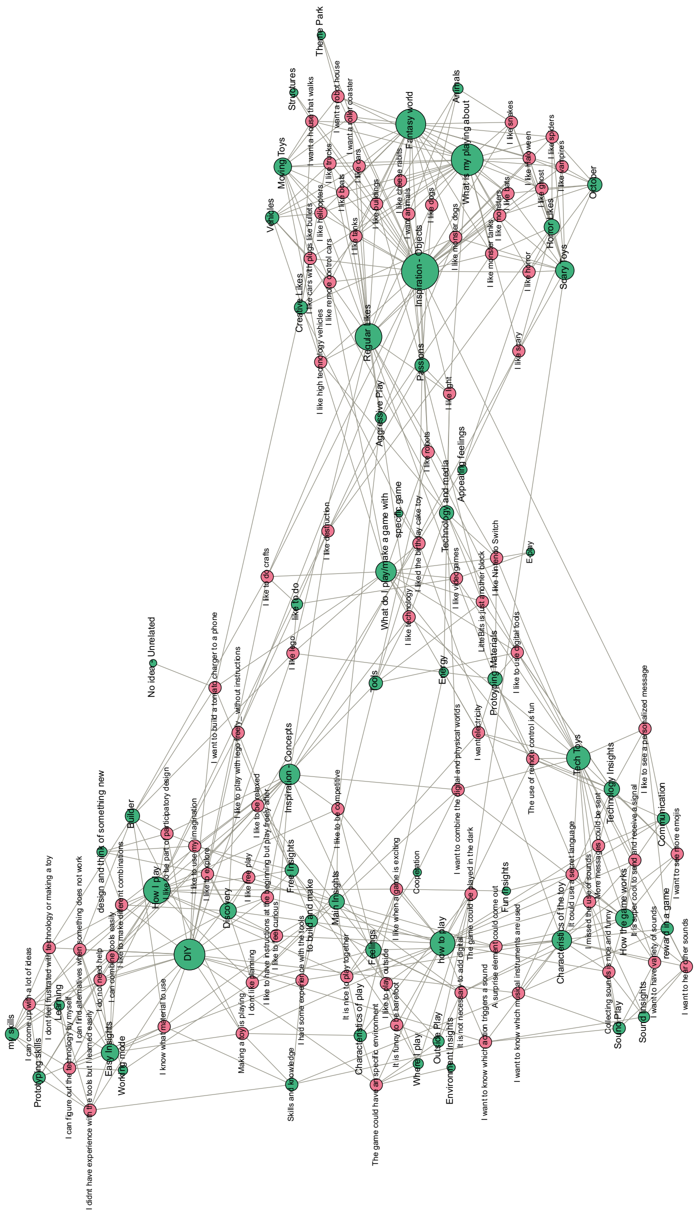

Figure 10 Network analysis

The cluster related to themes is tightly packed and the cluster around activities is spread out, therefore, we can identify themes that are around shared common interests. Moreover, there is a lot of diversity surrounding the concepts that deal with these themes. The statements indicate that the children made no clear distinction between the characteristics of the play experience and the toy (or toy system).

The results of the questionnaire used to assess the children's acceptance of the workshop show their enjoyment (Figure 11) and what they learned (Table 3). They also expressed their interest in learning more about robots, programming, making toys and the technical tools used during the workshop. In a short amount of time (five hours), they were able to build the prototypes, learn about the technology and discuss what they would like to see in their hybrid toys. As one of the children mentioned, "[these tools] add some magic".

Figure 11 Question on acceptance: "I thought it was a nice workshop"

I have learned…
How you can make robots
I have learned that everyone can figure things out

That we can use other things as a controller
How to make things with the switch
You can do more things if you know Little Bits

Table 3 Some statements of what children learned

5. Discussion

Prior studies have noted the value of co-creation in understanding users. The generated concept map further supports the idea of using co-creation of hybrid toys as a playful and educational experience to better understand user's needs. However, our findings may be limited by the number of participants, the lack of diversity among participants and cases of miscommunication with the observers. Although we believe that co-creation workshops can lead to a better understanding of a target group, further research should develop workshops with more diverse groups of children. Moreover, this approach should also include therapists, children and their families to identify what are the specific requirements of hybrid toys that can facilitate therapies.

Although some of the coaches acted as translators, one of the main issues encountered was the language barrier between observers and children. This study was conducted in The Netherlands were most of the participating children only spoke Dutch, while some of the observers did not speak Dutch. This will be taken into consideration for future studies.

Another limitation of the current study is that rating the importance was made by the observers, as an attempt to identify what they have learned from the users. It would be interesting to conduct a future study with bigger and more diverse groups of children and see how they would rate the statements themselves.

6. Conclusions

The aim of the present study was to understand the needs of children in their hybrid play experience and to examine co-creation workshops as a means to understand the user. This study has compiled a list of insights that can be a starting point for designing new prototypes of hybrid toys for use in health, and in other fields. These insights refer to different aspects: psychological needs, practical functionality, opinions, and requirements. They provide a rich overview of children's needs and thoughts about these types of toys. From a design perspective these insights help designers make informed decisions. This study has also found that empowering children with technology makes ideas more tangible and allows for richer design criteria to develop hybrid toys. The innovative aspect of this workshop is that it was not just about co-creation, but also tinkering with technology. While ideation and concepting provides useful information, prototyping with technology can trigger conversations about the needs of the user in hybrid play experiences. In this setting, children have the opportunity to experiment with these tools, have a more active role in the design of their toys and think about their potential.

The combination of co-creation and concept mapping can lead to valuable results when designing solutions by triggering and documenting ideas. The children who participated in the workshop expressed their interest in learning more about robots, programming, making toys and the tools used (Little Bits, Makey Makey and Nintendo Switch). From this we can conclude that it was a pleasurable experience for the participants and that this format could continue to be used to understand better the needs of the user. Despite the exploratory nature of the study, the results presented show that we, as designers, can identify the users' needs from working and playing alongside with them. In future studies we will analyse which specific elements, like sound for example, can be used to improve physical and occupational therapies.

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