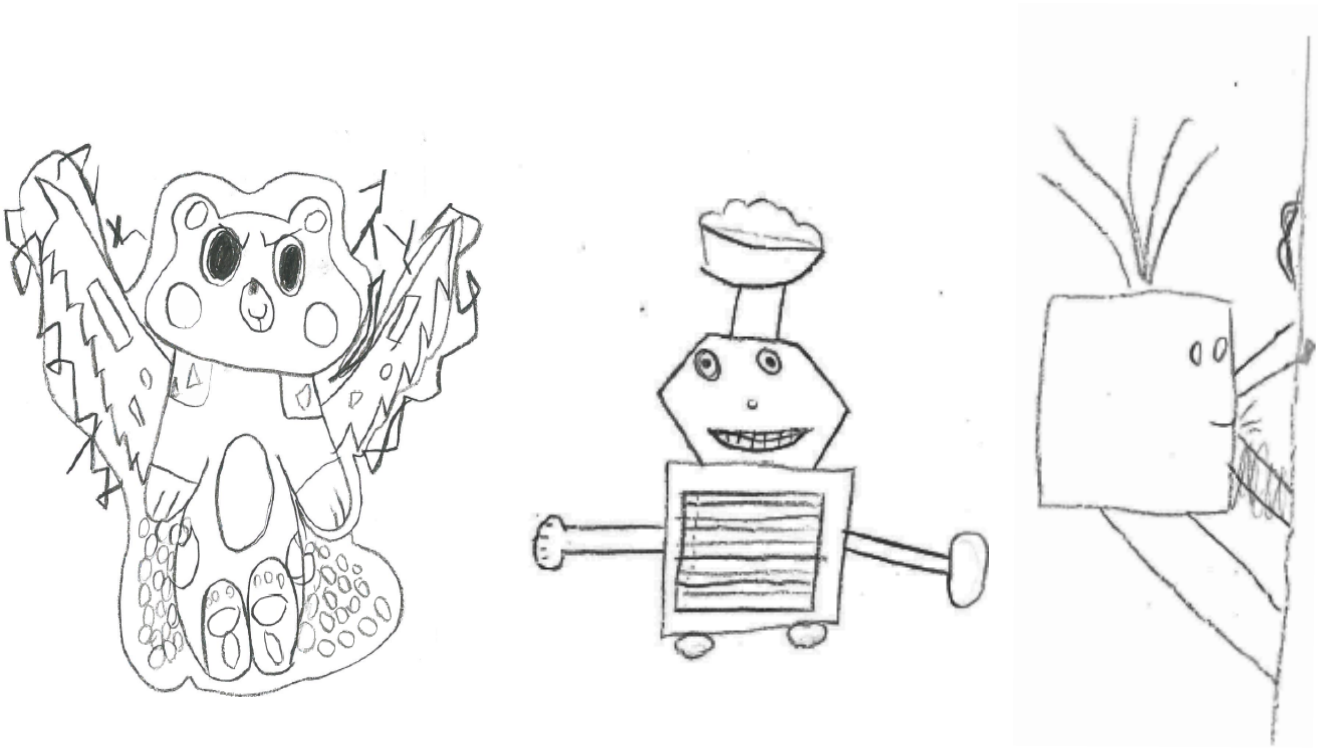
AALBORG UNIVERSITY
DENMARK

Line Thomassen Buus
Lotte Ishøy Jørgensen

Playful Design:

Developing a Facilitated Design Method for Children

Master's Thesis



AALBORG UNIVERSITET
STUDENTERRAPPORT

Department of Electronic Systems
Fredrik Bajers Vej 7B
DK-9220 Aalborg Ø

Title:
Playful Design: Developing a Facilitated Design Method for Children

Project Period:
10th semester:
2017.02.01 - 2017.06.08

Project Group:
1083

Group Members:
Line Thomassen Buus
Lotte Ishøy Jørgensen

Supervisor:
Lars Bo Larsen

Copies: 2

Pages: Report: 44 pages, Appendices: 111 pages

Enclosures, type: Additional_Appendices, zip

Finished: June 8th 2017

Abstract:

There are different approaches for including children in the generative phases of a design process, i.e. when ideas and concepts are developed. Yet, there is a lack of methods that both ensure that children's desires are part of the final product and are applicable to the industry, where resources are small. In order to fill this gap, we developed a low-resource Facilitated Design method, where children are the sole designers, and adults only facilitate. We did this by taking our starting point in the Future Technology Workshop and iterated on this method in order to make this Facilitated Design method suit 8-9 year old children's capabilities and ensure a useful outcome. We recruited 37 children through schools in Aalborg for three iterations in total. Following each iteration, we evaluated both process and outcome, after which we modified the method in attempt to improve it for next iteration. We implemented scaffolding techniques, motivation initiatives, and agreement tasks, among other initiatives. The final Facilitated Design method consists of Imagineering (brainstorming functions), Sketching (inventing a product concept), and Activity Generation (developing play activities for product concept). The method is applicable for the industry and ensures that children's desires are part of the final product. The method suits children's capabilities, yet, it is still possible to improve tasks to create a better outcome.

Danish Summary

I dette projekt har vi forsøgt at udvikle en designmetode, hvor 8-9-årige børn kan inddrages i de generative faser af en designproces. Her har det været essentielt, at metoden kunne anvendes i industrien, hvor ressourcerne er begrænsede. For at sikre, at resultatet passer til børns ønsker var det ligeledes vigtigt, at børns inputs blev medtaget videre i design processen, og at det ikke blot var designeren, som sorterede i børns input. Ud fra denne afgræsning forsøgte vi at udvikle en metode til Facilitated Design, der er tilpasset 8-9-årige børns evner og sikrer et brugbart resultat. Med Facilitated Design menes der en metode, hvor børn udvikler designs mens voksne faciliterer proceduren af idegenereringen og konceptudviklingen.

Vi tog udgangspunkt i Future Technology Workshop af Vavoula and Sharples (2007), da denne metode passede til de krav, vi havde opstillet for den metode, vi ønskede at udvikle. Vi tog udgangspunkt i faserne: Imagineering (brainstorm funktioner), Modelling (byg model af fremtidslegetøj), Role Play (udfør skuespil, der viser aktiviteter med fremtidslegetøj) samt Retrofit (revider skuespil, så der kun anvendes nutidig teknologi). Vi udførte to Future Technology Workshops med LEGO BOOST som case. Herefter analyserede vi videooptagelser samt resultatet af hver del af workshoppen kvalitativt. Denne analyse resulterede i en række temaer, som afslører, hvorvidt metoden var succesfuldt tilpasset 8-9-årige børn. Baseret på analysen listede vi alle problemer og implementerede nye tiltag i metoden, der potentielt kunne gøre metoden bedre tilpasset til målgruppen. Samme procedure blev foretaget gennem to øvrige iterationer. I alt rekrutterede vi 37 8-10-årige børn fra skoler i Aalborg Kommune. Baseret på disse iterationer var vi i stand til at foreslå en metode til Facilitated Design med børn kaldt Playful Design.

Playful Design består af tre sessioner: Imagineering, Sketching og Activity Generation. I Imagineering brainstormer de deltagende børn funktioner til fremtidige produkter i plenum. I Sketching er børnene opdelt i to grupper, hvor de resterende opgaver bliver præsenteret gennem en brætspil-lignende procedure. Hvert felt på spillepladen er en låge, som indeholder en delopgave. Når denne delopgave er udført, kan gruppen forsætte til næste låge. Gennem spillet vælger de én af de brainstormede funktioner som deres hovedfunktion, og bestemmer sig for hvilket produkt med denne funktion, de ønsker at udvikle. Ligeledes beslutter de et navn til produktet, hvilke egenskaber det skal have, samt hvilke underfunktioner det skal indeholde. De tegner herefter, hvordan deres produkt skal se ud ved først at tegne hver enkelt funktion og derefter samle hver enkelt funktion i et komplet produkt. Alle disse beslutninger, som foretages undervejs, bliver visualiseret på et manuskript, de kan bruge, når de præsenterer deres udviklede produkt til hinanden til sidst. I Activity Generation forsætter de med anden del af spillet, hvor Grupperne brainstormer aktiviteter til deres produkt og vælger deres favoritaktivitet. De udvikler et storyboard, der viser trinene i deres valgte aktivitet, og ligeledes tilføjer de elementer til en brugergrænseflade, så det tydeliggøres hvordan interaktion med deres produkt forløber i aktivitetens trin. De vælger den næstbedste aktivitet og gentager processen for et nyt storyboard. Til sidst laver de en videooptagelse, hvor de præsenterer alle elementer af deres legetøj såvel som deres valgte aktiviteter på en video til en vigtig person.

Med vores resulterende metode lykkedes det os at udvikle en metode til Facilitated Design, der er tilpasset 9-10-årige børns evner, ved først og fremmest at implementere scaffolding, visualisering af beslutninger, samt initiativer, der havde til formål at højne både ekstrinsisk og intrinsisk motivation. Vi opnåede desuden forbedringer ved at implementere en tegning til udvikling af produktet og storyboards til udvikling af lege-aktiviteter med produktet. Vi har demonstreret, at en opdeling af opgaver i underopgaver gør det lettere for målgruppen at komme i mål med opgaven, at ved at understrege betydningen af deres bidrag i designprocessen øges ekstrinsisk motivation, og at en spillignende struktur i workshoppen er nok til at få dem til at associere det med noget sjovt og dermed opnå intrinsisk motivation. Alligevel lykkedes det os

ikke at optimere alle opgaver i forhold til at opnå et brugbart resultat på alle punkter. Her var børnenes valgte funktioner og egenskaber til produktet ikke tilstrækkeligt sammenhængende, og deres produkter var ikke unikke. Ligeledes var børnene ikke i stand til at modificere deres produkt, så det blev realiserbart med eksisterende teknologi. Alt i alt betyder det, at det bliver designekspertens opgave at undersøge underliggende sandheder og interessante aspekter af børns legekoncepter samt at gøre dem realiserbare med eksisterende teknologi. Så længe disse problemer ikke er løst, bør børn kun informere designeksperter om hvilken retning designet bør gå. Derfor kræves flere iterationer, før metoden er fuldt ud anvendelig til Facilitated Design.

Preface

This Master's thesis has been completed at Engineering Psychology at Department of Electronic Systems at Aalborg University during the period February 1st to June 8th 2017. The project is made by Line Thomassen Buus and Lotte Ishøy Jørgensen, supervised by Lars Bo Larsen.

The purpose of the project has been to investigate how to develop a method for including children as designers. We have used the product LEGO BOOST as a case for testing our method, and we wish to thank Rune Fogh and the rest of the LEGO BOOST team for putting their expertise at our disposal and lending us the LEGO BOOST product. Also, we wish to thank Herningvej Skole, Sønderbroskolen, and Klarup Skole in Aalborg for participating in our design workshops, which has given us valuable insights.

Reading Guide

In this project, we use the APA citation style, e.g. Amabile (1983) or (Amabile, 1983). In the report, we mark certain terms with a '*'. This means that an explanation of these terms can be found in our definitions on the next page. If we refer to appendices or previous sections, the appendix/section number will appear in the reference, e.g. (see section 1) and (see appendix A). Bibliography and appendices can be found in the end of the report.

Appendices should be regarded as part of the thesis. They are left out of the report to keep it short and ensure a proper reading flow. Appendix A describes how children can be involved in design, appendix B-E contain theory that helped us develop a design method that suits children, appendix F describes LEGO BOOST, appendix G contains a list of several techniques for designing with children, appendix H-J concern our considerations for setting up the workshop, appendix K-S describe our evaluations through the method iterations, and appendix T contains a discussion of the method. Also, additional data and materials from the iterations can be found in additional appendices. An overview of contents in these can be found in appendix U.

Definitions

Approaches to including children in design (see appendix A):

- **Facilitated Design:** Involving users as the sole designers and minimising the researcher's/designer's role and impact.
- **Design Partner:** Letting children be designers i collaboration with adult designers through all design phases.
- **Balanced Design:** Involving children as design partners with adults, such that children make decisions in collaboration with adults, and adults and children have equal influence.
- **Informant:** Letting children come with inputs to design in one or more design phases.
- **Informant Design:** Involving children as informants that informs the design process, when adult designers believe that children's inputs are valuable.

Video introduction (see appendix J.1):

- **Inventor:** An actor from the video introduction to our workshops, who children are told can turn their ideas into real toys.
- **Invention:** The Lo-Fi prototyped control device that children pretend to use for controlling their toy in the workshops.

Group work issues (see appendix H.1.2):

- **Apart Together:** Instead of mixing ideas and working towards one solution, children follow their own interests.
- **Free Riding:** Taking advantage of work of others thereby disclaiming accountability and devoting less effort.
- **Laughing Out Loud:** Having a good time in the group, but being unwilling to take the task at hand serious, which may be caused by a lack of motivation or problem ownership.

Adult roles (see appendix K.3):

- **Facilitator:** When adults structure the session and the agenda, provide explanations, facilitate consensus within the team, clarify ideas, and ensure groups process in accordance to the schedule.
- **Motivator:** When adults praise and encourage children in order to motivate them within the session.
- **Participant:** When adults propose ideas or expand upon a child's idea.
- **Contribution Initiator:** When adults prompt children to contribute with an idea or opinion.
- **Behaviour Manager:** When adults prompt children to maintain a good behaviour.

Contents

1 | Involving Children in the Design Process

In this Master's thesis, we will investigate methods for involving children in the generative phases of a design process, i.e. where ideas and concepts are developed. We wish to develop a method that suits children's capabilities and results in a useful outcome. Also, it should be based on children's desires and be applicable outside university research.

The field of involving children in product- and service design is growing (Sluis-Thiescheffer et al., 2016), which is also the case for user involvement in general (Sanders, 2005). Up until the 1980's, designers typically either observed users or used the product themselves (Sanders, 2005). This focus then moved to primarily involving users to assess prototypes, which according to Sanders (2005) is the most common type of research at his time of writing. Yet including potential users in the generative phases of a design process is becoming more popular (Sanders, 2005; Vines et al., 2013) and various methods for including children in these phases have been developed through the years (Nesset and Large, 2004).

Also, there is a long list of benefits of involving children in generative phases. In these phases, designers should not rely on memories from their own childhood or intuitive assumptions (Gelderblom and Kotzé, 2009). Instead, children are the experts of what it means to be a child today (Guha et al., 2013). Based on their own experiences, children have insights into what motivates and engages them (Scaife et al., 1997), and since children are cognitively and physically different from adults, letting children participate in the design process may offer significant insights (Bruckman et al., 2008). In addition, children are effective contributors, because they are likely to provide spontaneous and fewer socially desirable responses than adults might do (Vaughn et al., 1996, p. 132). The advantages of involving children are large in terms of innovation and usefulness (Nesset and Large, 2004). Without their cutting-edge and often visionary ideas, technology would stagnate (Guha et al., 2013). In sum, many researchers have demonstrated that children can be brought into the design process with great profit. Less clear is how to involve children and what role they should have (Scaife et al., 1997; Nesset and Large, 2004).

Yet, there are some challenges of involving children in the generative phases, such as high time consumption and children's cognitive limitations. The latter concerns issues in verbalising thoughts (Druin et al., 1997; Druin, 2002; Markopoulos and Bekker, 2003; Oosterholt et al., 1996), difficulties in understanding the task (Nesset and Large, 2004), and issues with boredom (Nesset and Large, 2004). Likewise, Markopoulos and Bekker (2003) have experienced that children have difficulties with conducting goal directed tasks and judging whether they are done correctly, with concentration, and with tasks being too complex or profound (Markopoulos and Bekker, 2003). Thus, we need to overcome these challenges when including children in the design process.

In this report, we will investigate how to cope with children's cognitive limitations when involving them in design. This is done by first determining what role children should have in generative design phases, choosing a method that fits this approach, and iterating on this method. We wish to test and improve design techniques through workshops to reach a method that suits children's capabilities.

2 | Our Approach to Design with Children

In this chapter, we present how we will investigate methods for involving children in the generative phases of a design process. First, we present our case for testing out design techniques. Then, we specify the target group and determine the best suited approach for including children when designing outside university research. On the basis of this approach, we set up method requirements to be able to choose a design method and choose the method that will be our basis for further development. Throughout the rest of this Master's thesis, we will iterate on improvements in order to make it suit children's capabilities.

2.1 LEGO BOOST

When developing a method for designing with children, we need a case for testing the method. When designing technology for children, there are two main categories products fall into: education or entertainment. Entertainment design is solely for fun and enjoyment, while designing for education involves analysing learners and teachers' needs, choosing an approach for teaching and learning, making sure to support the curriculum, and analysing the learning outcomes. (Bruckman et al., 2008)

We will focus on entertainment products, and for this project we use the product LEGO BOOST. LEGO BOOST is a creative toy, where the child builds the model with LEGO bricks, code its behaviour on a tablet, and play. With simplified icon-based drag-and-drop coding, BOOST enables boys and girls to bring their LEGO creations to life with technology. (LEGO BOOST, 2016)

The main model can be seen on figure 2.1.

Figure 2.1: The main model for LEGO BOOST called Vernie (Lego.com, 2017).

LEGO BOOST consists of five models with different predetermined play activities (e.g. make the model Vernie become a comedian that tells jokes) (LEGO BOOST, 2016). Based on this, our focus for designing with children will be on developing models and activities for the LEGO BOOST platform. This product is interesting for our purpose of developing a design method, because at the time of writing (Spring 2017), LEGO BOOST was not yet in stores, which means that children will not be not affected by any conceptual understanding or expectations of what LEGO BOOST is. As children will not know the concept, developing new models and activities for LEGO BOOST will be similar to developing a new product.

Further description of LEGO BOOST can be found in appendix F.

2.2 Target Group

Because we use LEGO BOOST as our case, we wish to develop a design method that suits the target group of LEGO BOOST, which is boys and girls aged 7-12 years. This matches Druin et al. (1998)'s recommended age group of 7-10 years for involving children in the generative design phases. This age group is verbal and self-reflective enough to discuss what they are thinking and understand the abstract idea of designing something for the future (Vaughn et al., 1996, p. 136; Druin et al., 1998). In addition, Druin et al. (1998) argue that this age group does not seem consider pre-conceived notions of how things are supposed to be as much as older children do.

Yet, developmental differences exist between 7 and 10 year old children, such that a method suited for 10 year old children might not suit 7 year old children (see appendix B.2). Thus, we choose to narrow down our target group even further. The sweet spot of the LEGO BOOST target group is 8-9 years, i.e. they see this age group as their main users (see appendix F). Therefore, we choose to focus on 8-9 year-old boys and girls when developing a design method for children.

2.3 Approaches for Involving Children in the Generative Phases

When involving children in the generative phases of a design process, there are different approaches to how much children contribute, which are dependent of the role they are given. In Informant Design*, children are informants*, who gives inputs to design experts. Here, it is still the design experts who are in charge of all decisions, which consequently means that children's impact on the product development is dependent on design experts' willingness to use children's inputs (Druin, 2002). This is not optimal, as children's desires potentially can be misinterpreted or lost. Thus, we do not wish to take the Informant Design* approach.

Instead, it is possible to strive for equal design partnership, where both children and design experts are engaged in making decisions and realising ideas (Druin, 2002). This approach is called Balanced Design* (Read et al., 2002). Druin (2002) argues that children should have this role as design partners* for the resulting product to fully meet the children's needs.

In Druin (2002)'s method for Balanced Design*, the same children act as design partners* through all design phases, i.e. not only the generative phases. Yet, the long-term commitment with children means that methods using children as design partners* might conflict with some of the most crucial parameters for the industry. In relation to this, Williamson (2004) points out that a design partnership is impractical due to the ongoing cooperation with the same children, and because it does not suit larger groups of children, since it requires an equal number of design experts and children. He concludes that it is an approach that fits university-founded research better than the industry. Therefore, time and financial constraints may make the Balanced Design* approach infeasible.

Even if we narrow down Balanced Design* from being a long-term commitment to being a single workshop, we do not overcome one of the main problems with having children as design partners*, which is troubles overcoming power relations between children and adults, where adults are in charge (Scaife et al., 1997; Scaife and Rogers, 1999; Druin, 2002; Guha et al., 2013; Nesset and Large, 2004). Guha et al. (2013) have experienced that this equal power relation in Balanced Design* takes time to learn for both parts, but that it often is a matter of months, and Scaife et al. (1997) questions whether adult designers will ever accept children as their peers. Also, both Scaife et al. (1997) as well as Markopoulos and Bekker (2003) have experienced that not all children are able or willing to be design partners*, because they are inhibited by having to talk to unfamiliar adults.

Instead of focussing on Balanced Design*, where children are involved as design partners*, we suggest that children collaborate with only each other in developing ideas and concepts, i.e. children become the designers, and the adult role is minimised, such that only few adults are required. This means that children by themselves generate ideas and redefine ideas into concepts. Read et al. (2002) refers to this as Facilitated Design* (see figure 2.2), and we use this term for our method approach as well. With this approach, all decisions must be made by children alone, and adults' opinions are only relevant after concepts are fully developed. Furthermore, child-adult power relations become less influential compared to Balanced Design, and we still maintain the children as experts and decision-makers.

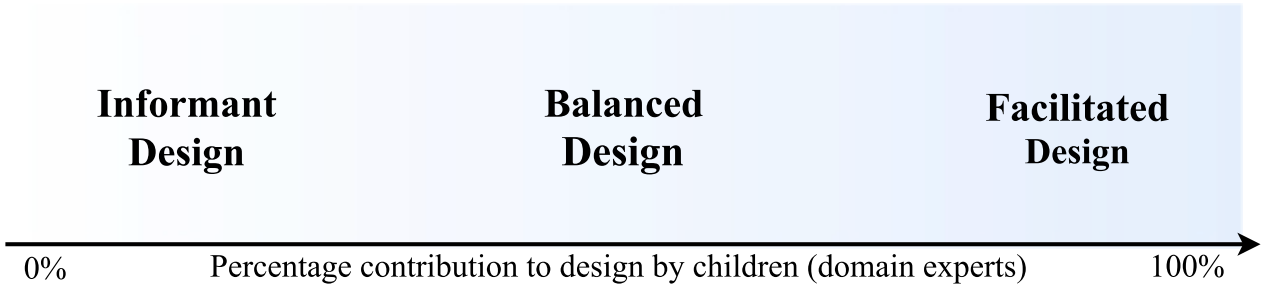


Figure 2.2: Approaches for involving children in the design process. Adapted from Read et al. (2002).

In sum, Facilitated Design* is both the best match for the industry and ensures children's influence. Yet, all methods within the Facilitated Design approach do not necessarily fulfil all the requirements from the industry. Thus, we must set up requirements for our choice of method to make sure that it fulfils the requirements from the industry. Likewise, the method must be suited for developing entertainment products. Therefore, our method must:

1. Require few resources:
   (a) Require few design experts.
   (b) Only require for the same children to participate in one session.
   (c) Require minimal training of participants.
2. Be applicable for developing ideas and concepts for an entertainment product.

Based on these requirements, we want to develop a Facilitated Design* method for 8-9 year old children.

2.4 Research Question

In order to fit 8-9 year old children, the Facilitated Design* method must suit this age group's abilities and ensure a useful outcome. In relation to this, Mazzone et al. (2010) and Sluis-Thiescheffer et al. (2011) argue that suitability and capability are important constructs in addressing the usefulness of design techniques. Mazzone et al. (2010) define these constructs as:

- Suitability: how well the chosen techniques are able to engage children as active participants. To ensure this, techniques should be usable and accessible to children, and thus the method should take children's cognitive skills into account.
- Capability: how well the chosen techniques are able to make children produce useful results. Capability is dependent on children's ability to accomplish the tasks that produce design ideas.

Based on this, our research question is:

How do we design a Facilitated Design method that is suitable to 8-9 year old children and ensures high capability?

When focusing on Facilitated Design*, the role of the facilitator becomes important as well. Thus, the Facilitated Design* method should ensure that adults stick to facilitation and do not give input on design, start to make decisions, or the like (see appendix K.3 for a clarification of adult roles).

2.5 Choice of Facilitated Design Method

Based on our method requirements, we have examined existing methods for designing with children of different ages in both Informant*, Balanced*, and Facilitated Design*, in order to get an overview of which methods we can apply directly or modify to fit Facilitated Design* (see appendix G).

Our examination has revealed that few studies have involved children as designers, i.e. conducted Facilitated Design*. As to our knowledge, only Kafai (1996, 1998) and Read et al. (2002) have conducted Facilitated Design* with our target group. Kafai (1996, 1998) used children as the sole designers of software, but the process took several months, which does not fit our requirements. Read et al. (2002) used 8-10 year old children as designers, but they had little success, as they had problems with children's collaboration and child-adult power relations. Based on this, the most logical option might seem to be trying to improve collaboration and power relation issues of Read et al. (2002)'s method. Yet, the method has not been described in details, and thus, it is difficult to identify why issues raised. In addition, the method used by Read et al. (2002) seem to be founded in problem-solving, which is not optimal in our case. Our focus on entertainment products means that we do not try to solve any problems or support everyday activities, but rather develop new and exciting concepts.

Vavoula et al. (2003) have conducted Facilitated Design* using 10-13 year old children, which are slightly older children than our target group, but the closest fit we have been able to find. Their method is called Future Technology Workshop and fits our method requirements, because it:

1. Requires few resources:
   (a) Requires only 2-3 researchers.
   (b) Only requires for the same children to participate in one session.
   (c) Requires no training of participants.
2. Focusses on developing ideas and concepts.

The idea behind Future Technology Workshop is to develop radically new or disruptive concepts by thinking of the future rather than analysing everyday activities. In one workshop, participants collaborate in group activities, where they elaborate on far future, near future, near past, and present through activities such as brainstorming, prototyping, and role play. The method uses people with everyday knowledge in designing future technology and activities. This means that participants are required to be familiar with the domain of interest, but not to be technology experts. (Vavoula et al., 2002; Vavoula and Sharples, 2007)

Future Technology Workshop consists of 7 techniques which can be applied during one day (Vavoula et al., 2002; Vavoula and Sharples, 2007). In our case, only the first four techniques are useful, because the following techniques of Future Technology Workshop focus on activities that participants currently perform in daily life, problems they experience in daily life, and improvements of current technology. Since we focus on entertainment products, we do not try to solve existing problems. Therefore, we evaluate these last techniques as less relevant in our case. Using only the first four techniques, the children think about future activities and designs, and they end up making their ideas applicable with existing technology.

These four techniques are Imagineering, Modelling, Role Play, and Retrofit. Imagineering has the purpose of setting the scene for the rest of the workshop by letting participants think of future technology in a brainstorm. With the Modelling technique, the purpose is for participants to create models that are useful and meaningful in the context of inventing a futuristic product. The purpose of Role Play is to bring the future into the present by enacting an activity as if the product existed, thereby making ideas more tangible. The purpose of Retrofit is to let participants think of how futuristic activities might be adapted into their current lives by thinking of existing technology and enacting it in a modified role play. (Vavoula and Sharples, 2007)

These four techniques should take 2 hours to complete (Vavoula and Sharples, 2007). However, it is worth to mention that 8-9 year old children are only able to concentrate for one hour when doing homework (Dawson and Guare, 2010, p. 10). Still, this does not mean that we will limit the workshops to one hour. We keep the 2 hour time schedule, because the workshop is made up of different activities, in which they do not necessarily have to be as concentrated as when doing homework.

Even though this method fits our requirements, we do not know whether Future Technology Workshop suits 8-9 year old children or if the techniques make this age group capable of developing useful concepts. As previously mentioned, Vavoula et al. (2003) has succeeded in applying the method with children aged 10-13. According to Piaget's cognitive development theory, 8-9 year old children are in the Concrete Operational Stage, and 10-13 year old children are mainly in the Formal Operational Stage, which makes their level of development much different (see appendix B), especially in their way of thinking. Thus, Future Technology Workshop might not suit 8-9 year old children. Investigating whether it is the case or how we potentially can improve suitability and capability will be our main focus from here.

In the following chapters, we will describe how we iterated the method and analysed the workshops we conducted. Afterwards, we present each iteration by going through procedure, sum-up of findings, and main changes for next iteration. Then we evaluate, how our method has improved through the iterations, discuss whether we have been able to design an applicable method for children as designers in Facilitated Design*, and discuss the generalisation of our method. This is followed by a presentation of our recommended method and a conclusion on the project.

3 | Iterating on Facilitated Design Method

We used Future Technology Workshop as a baseline with 8-9 year old children without making any changes to the method, which we refer to as Baseline. This gave us clear signs of issues of the method that needed to be taking into account with this age group. After this, we removed some of the experienced issues through new iterations. We ended up with three iterations, which we call Baseline, Iteration 1, and Iteration 2.

In each iteration, we conducted two workshops, which we refer to as A and B, e.g. Baseline A and Baseline B. It was not determined beforehand that we would run two workshops per iteration, however, we experienced saturation after two workshops, where we had insights into the main issues of the method.

In the following, we will describe how we set up the workshops and analysed each iteration.

3.1 Setting up Workshops

We conducted the workshops at three different public schools in the area of Aalborg, Denmark (see table 3.1). We contacted the schools by email, and after an arrangement was settled, we sent sent out invitation letters to parents after. A detailed description of this procedure can be found in appendix J.2.

Workshop	Date	School	N	First Group	Second Group
Baseline A	2017-03-15	Herningvej Skole	6	Group 1: Boy 10, Girl 10, Girl 9	Group 2: Girl 8, Girl 8, Girl 8
Baseline B	2017-03-16	Herningvej Skole	7[1]	Group 3: Boy 8, Boy 8, Girl 8	Group 4: Girl 9, Boy 9, Girl 9, Girl 9
Iteration 1A	2017-03-30	Sønderbro-skolen	6	Group 5: Girl 8, Girl 8, Boy 10 (D16)	Group 6: Boy 8, Boy 9, Girl 9
Iteration 1B	2017-04-06	Sønderbro-skolen	6	Group 7: Girl 8, Boy 8, Boy 8	Group 8: Girl 8, Girl 8, Girl 8
Iteration 2A	2017-04-27	Klarup Skole	6	Group 9: Boy 9, Boy 9, Girl 9	Group 10: Boy 10, Girl 9, Girl 10
Iteration 2B	2017-05-03	Klarup Skole	6	Group 11: Boy 10, Boy 10, Boy 10	Group 12: Girl 9, Girl 9, Girl 9

Table 3.1: Overview of workshops.

We chose to conduct the workshops outside of school-time, where we conducted the workshops in after school centres. We chose this, because children might not expect to be told what to do by adults to the same degree as in school-time, and thus not be as limited in group discussions as Read et al. (2002) experienced when conducting Facilitated Design* in school-time. Another benefit is that keeping them in a familiar environment ensures less distraction (Mazzone et al., 2011).

We facilitated the workshops ourselves. We wished to have a facilitator represented in each group, first, not to be overwhelmed by the amount of children, like Vaajakallio et al. (2010) have experienced, and second, because it both gives children the opportunity to ask questions at all times, and facilitators can show respect

[1]Baseline B was conducted with 7 children, as some communication and planning with the school went wrong.

for children's ideas and state the importance of their contributions, which provide a safe environment for creative thinking (Fyfe, 1985). For further reading, see appendix I.

When making groups, we did some considerations regarding group composition. Heary and Hennessy (2002) found that 4-6 children in a focus group is generally recommended. Yet, this might likely be too many children in one group in a design workshop, if we want to keep them all active, i.e. avoid Free Riding*. Van Mechelen et al. (2015) have experienced Free Riding* because some felt they could not contribute. Thus, we chose to include 6 children at the time, such that there were 3 children and one facilitator in each group, and we split the groups into separate rooms to avoid cognitive tuning (Fern, 2001, p. 104). Yet, some parts of Future Technology Workshop involve having all children in the same room. Therefore, we used the two set-ups illustrated on figure 3.1 and 3.2.

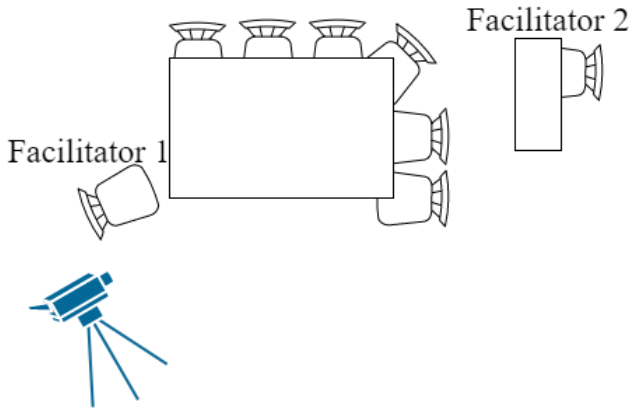


Figure 3.1: Workshop set-up when groups were gathered. This set-up was roughly the same during all six workshops (Baseline, Iteration 1, and Iteration 2).

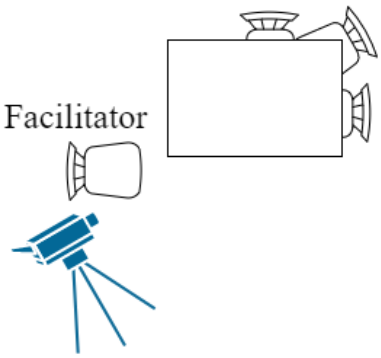


Figure 3.2: Set-up for group work when groups worked in two separate rooms. This set-up was roughly the same during all six workshops (Baseline, Iteration 1, and Iteration 2).

As we did not know the children beforehand, we created groups based on our impressions from the first part of the workshop and in collaboration with the children. This was done based on both friendship and who we thought would be able to behave as a part of the same group. Friendship groups previously have led to good results (Lewis, 1992). Further argumentation for our choice of groups can be found in appendix H, including a discussion of optimal group size and composition.

To introduce the LEGO BOOST case, we made a video introduction, using the method called Obstructed Theatre, which is a method that help eliciting ideas from children when designing novel products (Read et al., 2010). In the video, a fellow student acts as an inventor, who tells one of the facilitators about a new invention she is making. We chose to introduce the concept of LEGO BOOST as a new invention that can control any toy, i.e. the invention is some kind of control device. As the conversation go, the inventor introduce more functionalities. How the invention works or looks is not described - only that it can control future toys to do anything. See appendix J.1 for more information about the introduction video. When we use the words inventor* and invention* throughout the following chapters, we refer to this video introduction.

Also, in all iterations we conducted a short interview in the end of workshops to support data from the workshops. We asked children what they thought about being part of the workshop, including if they liked being inventors, if they would recommend friends to participate, and what was fun and boring.

3.2 Evaluating Facilitated Design Method

In order to modify Future Technology Workshop such that it suits our target group, we evaluated our workshops. Design methods can be evaluated both based on the process and outcome (Mazzone et al., 2012), and we chose to do both. As our research question states, we were interested in measuring suitability and capability.

To ensure capability, it is important to evaluate the outcome. Shah et al. (2003) define four constructs for evaluating the outcome of a design method: variety (how well the design space is explored), novelty (how non-obvious ideas are), quantity (number of generated ideas), and quality (how thorough an idea is). We set up requirements for the outcome of each task and evaluated whether groups succeed in fulfilling the requirements. If groups managed to do so, we expected them to end up with a useful outcome. Our requirements are based on Vavoula and Sharples (2007)'s requirements as well as novelty and quality. Based on our findings from one iteration, we modified our requirements to fit the new techniques that we introduced in the new iteration. A discussion of what requirements to set up, the list of requirements, and the evaluation can be found in appendix R.

To know how to improve suitability and capability, it is also possible to evaluate the process. According to Shah et al. (2003), process based evaluations of idea generation methods are time consuming and complex. However, only evaluating the outcome does not reveal children's participation during the workshops and how techniques fit their cognition. Therefore, we chose to evaluate the process as well. We used a qualitative method to evaluate the process. Here we used Braun and Clarke (2006)'s thematic analysis, which Benton and Johnson (2014) previously used to evaluate a design method for children. In our thematic analysis, we took a 'top-down' theoretical approach, where the data analysis was driven by our theoretical interest, as we have theoretical justification for typical child collaboration, child participation, and adult facilitation.

For our evaluations, we collected data by videotaping the workshops. Presentations on video along with produced material was our basis for the evaluation of outcome. Furthermore, we used the video material for our process based evaluation. In our process based evaluation, we first familiarized with data by watching the video material. Then we went through the video material doing initial coding of relevant data extracts, and then transcribed these data extracts. Next, we did a closed coding by sorting these initial codes into predetermined categories that we had made based on theoretical constructs. Then, we defined sub-categories within these closed coding categories, and searched for themes across all sub-categories. Themes captured something important about the facilitation, suitability, and capability. When we had ensured internal and external homogeneity, we defined names for themes, and ended our analysis by writing a detailed description of each theme, where we included findings from our outcome evaluation. Further description of our analysis method as well as predetermined closed coding categories can be found in appendix K.

We evaluated the data after each iteration, as the outcome of the evaluation guided next iteration. This helped determining what aspects of the method that required modifications and what we needed to keep as part of the method. Based on the themes, we were able to list all issues experienced in an iteration. We evaluated how critical each issue was based on figure 3.3, and using this severity-diagram, we knew which issues that were most crucial to solve. Further description of our severity-score can be found in appendix K.4.

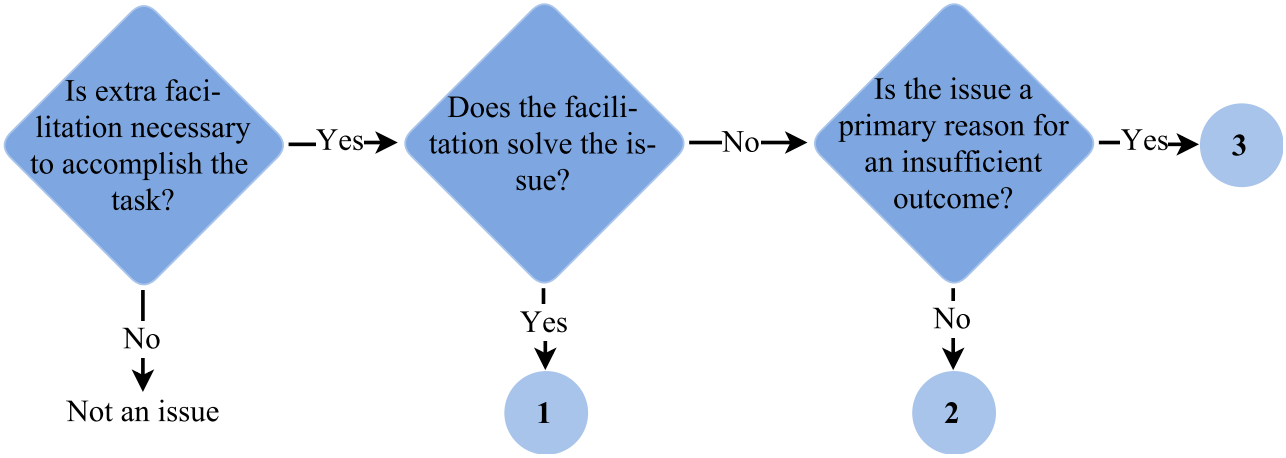


Figure 3.3: Severity-diagram that we used to evaluate how severe each issue was. Issues were evaluated from left to right.

In the following chapters, we present each iteration, what themes we found, and what changes we made in order to solve the issues.

4 | Baseline

In this chapter, we present the procedure of the Baseline workshops using Future Technology Workshop by Vavoula and Sharples (2007). Afterwards, we present the themes found after applying this method.

4.1 Procedure Baseline

This test was set-up on the basis of the four first parts of Future Technology Workshop. In between Baseline A and B, we did not analyse any data, but made minor improvements based on our impressions of how the workshop went. These improvements did not concern any change of techniques. We chose to do so, because some issues were already very clear after the first workshop, and thus we might just as well try to solve these issues to make the most of the second workshop. The changes for Baseline B are presented along with the procedure for Baseline A. A detailed description of the requirements for each session is to be found in Appendix R.2.

Introduction (10 min)

The introduction has not been described by Vavoula and Sharples (2007), and hence, we create our own. We start the workshop with having one facilitator introduce herself and the other facilitator. Then, all children and facilitators write a name tag followed by a round, where each child and facilitator tell their name and age in order to make children feel comfortable talking (see appendix I). Then the children are introduced to the purpose of the workshop, i.e. to be inventors, and then we have a small discussion about what an inventor is. After this, we introduce what they are going to invent through the video introduction (see section 3.1).

We made no changes for Baseline B.

Imagineering (10 min)

In Imagineering, a facilitator gives the children a brainstorming task. The task is: *in which ways would it be fun to play with future toys, if you had the invention*?* The children then brainstorm future activities out loud, and both facilitators note down ideas, such that two sets of the same ideas are made for later group work tasks. When necessary, the facilitator prompts the children to think about the far future in order to make the ideas more novel.

Changes for Baseline B:

- The task was changed to concern brainstorming functions: *What could be cool that a futuristic toy could do, if you had the invention*?* (because it was abstract to brainstorm activities).
- Show them a Lo-Fi prototype of the invention* (to make them remember the invention* through the whole session).

Modelling (40 min)

Within this session, children are split into two groups and given low-tech prototyping materials, including modelling wax, coloured pencils, paper, straws, yarn, and ice-lolly sticks. Each group selects some of the ideas generated in Imagineering and creates a model that illustrates how the activity will be performed. In addition, the group writes a short description of it. The Modelling session ends with a presentation of the model to the other group.

Changes for Baseline B:

- Before selecting ideas from Imagineering, the facilitators read out loud all ideas (to ensure they remember all ideas).
- Make them base their selection of ideas on what would be cool for their toy to do (to give them a concrete criteria for selecting ideas).
- Make them decide what they want to build before handing out the low-tech prototyping materials (to make them focus on the actual task rather than materials).
- Introduce the description as something they should do in the end, and prompt them to write it in the end of the session (as they forgot to make the descriptions).

Role Play (30 min)

The groups exchange models from the Modelling session. Afterwards, groups make up a scenario for use of the model and enact it in a role play. Vavoula and Sharples (2007) suggest to use 'who-where-what-how-idea' cards by Ihlström et al. (2005) to structure the scenario building. Therefore, if it becomes necessary, we apply these cards, e.g. by asking participants: "who is a part of the play?" or "where does the plot take place?". After rehearsing the role play, they present it to the other group. The other group, i.e. the original designers of the model, comment on whether it was the activity that they imagined.

Changes for Baseline B:

- Remove all Modelling material from the room (to avoid any unnecessary distractions).

Retrofit (30 min)

This session takes the ideas back to existing technology. The groups of children modify their scenarios in order to only use existing technology. As a help, Vavoula and Sharples (2007) propose to display existing technologies in various ways. We present the technology of the LEGO BOOST model Vernie by showing some activities that it can do. The groups act out scenarios once again.

We made no changes for Baseline B.

4.2 Baseline Themes

After conducting the workshop with the above procedure, we analysed our data using thematic analysis (see section 3.2) and combined it with our evaluation of the outcome. The following is a sum-up of themes of Baseline. A thorough description of themes can be found in appendix L. Our qualitative analysis resulted in 3 themes with sub-themes (see figure 4.1).

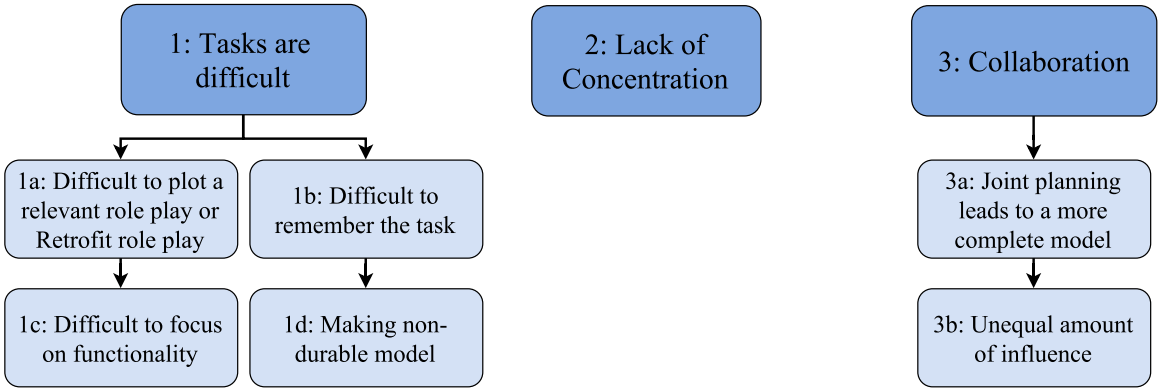


Figure 4.1: Themes from Baseline.

Theme 1: Tasks are Difficult

Throughout the workshop, children had troubles completing the tasks.

In *difficult to plot a relevant role play or retrofit role play (sub-theme 1a),* we describe that children had troubles getting started when asked to make a plot for the role play, and when they did, they tended to create irrelevant plots, i.e. they based the plot on other functions than what the previous group had planned for the model, and the plots did not always concern playing with the model. In Retrofit, the same issues appeared, and in addition, they included activities that they saw Vernie perform instead of using Vernie's hardware for their retrofit. Furthermore, sometimes brand new plots were developed instead of refining the previous. It resulted in difficulties presenting the retrofitted role play to the other group. All of this means that the outcome of Role Play and Retrofit was very limited.

Difficult to remember the task (sub-theme 1b) describes that throughout the workshops, the children tended to forget what they were instructed to do, i.e. forgot about the invention*, forgot some sub-tasks, and forgot details of the instructions.

The next sub-theme reveals that it is *difficult to focus on functionality (sub-theme 1c)*. Instead they focussed on objects in Imagineering and aesthetics in Modelling, which caused troubles describing the functionality of their model in the Modelling presentation.

The last difficulty was visible in *making non-durable model (sub-theme 1d)*. They had troubles crafting due to the feeling of time pressure, difficulties making the materials clutch properly, and heavy modelling materials. Thus, the facilitator had to help to get them finished in time. They ended up spending time repairing the model in the following sessions.

Theme 2: Lack of Concentration

Throughout the workshop, children tended to lose focus. In Modelling, a lot of Free Riding* and Laughing Out Loud* happened. In Role Play and Retrofit, Laughing Out Loud* happened to such a degree that these unfocused children took the attention of the child(ren) working on the task in Role Play, which lead to frustration or embarrassment by the working children, and often the adult needed to act as a Behaviour Manager* or Contribution Initiator*. Also, in general, it was hard for the children to sit down in the latter part of the workshop.

Theme 3: Collaboration

Equality of contribution and approach to group work were different in the groups, where some were better at collaborating than others.

Joint planning leads to a more complete model (sub-theme 3a), as groups that planned together ended up feeling that their models were finished. When groups had troubles planning, it resulted in different mental models of what they were building, Apart Together* work, frustration, and unfinished models.

Unequal amount on influence (sub-theme 3b) means that in general there were unequal child-child power relations. In group work, some children were very dominant to others, as some talked condescendingly to others, rejected their inputs, or acted self-centred. This resulted in some children giving up on contributing or always seeking accept for their contributions. Also in Imagineering, we experienced dominating behaviour, as some started speaking before having an idea just to be heard by adults. Likewise, we experienced children that were afraid of contributing in Imagineering.

As these themes show, there were some capability and suitability issues with the applied method. In the next iteration, we tried to deal with these issues.

5 | Iteration 1

In this chapter, we present Iteration 1 and a sum-up of the themes we found. First, we introduce the changes we made, state the new procedure, and end the chapter with a sum-up of the themes we have found by analysing the workshops.

5.1 Changes for Iteration 1

In order to solve the issues experienced in Baseline (see section 4.2), we made some initiatives for Iteration 1. These initiatives should respond to all Baseline issues. In the following, we describe the most crucial changes of the method that should solve the most severe issues. A deeper description of changes can be found in appendix M, where a list of all issues is presented as well as argumentation for each initiative.

In the introduction to the workshop, we included an Icebreaker, as we experienced that some children were reticent in the beginning of the workshop (sub-theme 3b). We chose the icebreaker Tall Stories (Knox, 2012), where participants build upon a story by coming up with a sentence and ending it with ”but suddenly”, from which the next in line continues the story. This meant that all children got to talk in an early activity that had no right or wrong answers. In addition, to cope with the concentration issues (theme 2), we tried to motivate children extrinsically in the introduction to the workshop by stating the importance of their contributions (Hanna et al., 1997) and that their ideas potentially could turn into real toys.

We acted upon lack of concentration (theme 2), unequal contribution (sub-theme 3b), and Apart Together* work (sub-theme 3a), when introducing accountability roles: seriousness general, everyone-decide guard, and collaboration captain with inspiration from Van Mechelen et al. (2015). Each member of a group got one of these responsibilities to ensure collaboration and sticking to the task.

In Modelling, we began to split tasks into sub-tasks to cope with collaboration issues (sub-theme 3b) and issues about not knowing what to do (sub-theme 1b). As Sluis-Thiescheffer et al. (2011, 2016) have used the Nominal Group Technique with children, children in our workshop should now vote on ideas by individually noting down their three favourite ideas and afterwards agree on 3-5 ideas. The largest initiative in Modelling was implementing the technique Drawing by Large et al. (2007). We believed that it would address Apart Together* work (sub-theme 3a), lower time pressure by having a plan before building the model (sub-theme 1d), and ensure that children focus on functionality instead of materials or aesthetics (sub-theme 1c). We believed that it would be easier to plan what toy they will invent when drawing before building a model of the toy. In appendix G, we explain the Nominal Group and Drawing techniques in more detail.

Because of major suitability issues with Role Play, we replaced Role Play with a session called Activity Generation, where we facilitated a brainstorm on activities for playing with their invented toy and afterwards children filled in cards about their chosen activity (see figure 5.1). Each card was a piece of paper that contained a number of sentences to finish one by one. Each sentence clarified something about their chosen activity. They were to describe the play concept; which functions the toy used for performing the activity; what other objects that were needed in order to play it; the best place for playing it; and who they would play it with. The cards were an attempt to address Laughing Out Loud* (sub-theme 2), that they forgot what the task was about (sub-theme 1b), and that they did not make a plot that concerned playing with

the toy (sub-theme 1a), since this approach had more structured sub-tasks, making it easier to complete tasks compared to Role Play. Furthermore, to make children remember the functionality of their model (sub-theme 1a), we chose to make groups build upon their own models instead of exchanging models after Modelling.

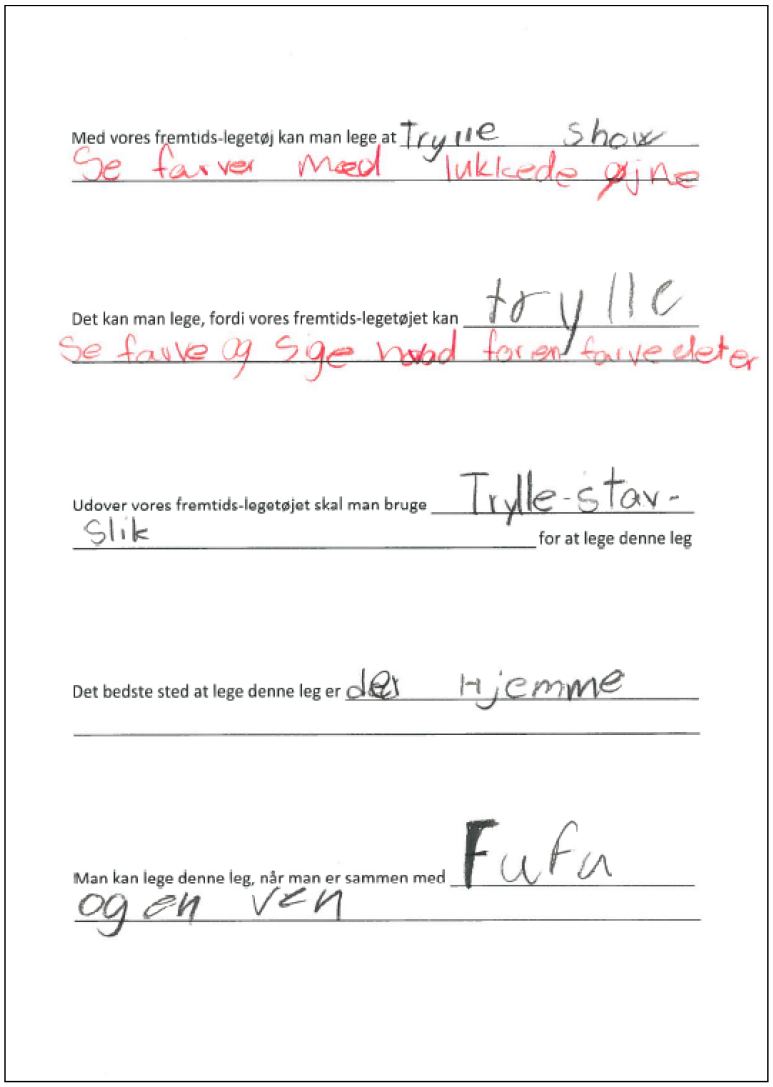


Figure 5.1: Group 8's card filled in during Activity Generation and Retrofit. Black text is from Activity Generation, and red text is from Retrofit.

Since Role Play was replaced, we also replaced the role play in Retrofit with a modification of the cards from Activity Generation, where the groups were to revise their cards into what is actually feasible with LEGO BOOST technology (see red text on figure 5.1). Here, groups decided what lines to modify. We expected this to prevent them from making brand new activities (sub-theme 1a) and not understanding what to do (sub-theme 1a), because the task was more tangible. Furthermore, we tried to avoid that children implement Vernie's activities by introducing Vernie's motors and sensors before showing the activities he can perform.

In general, these changes attempted to make it easier for children to accomplish the tasks and to collaborate. To do so, we especially used scaffolding (i.e. techniques to make the task less comprehensive) in making tasks easier. See appendix C for a description of scaffolding.

5.2 Procedure Iteration 1

Based on the issues experienced in Baseline, we changed parts of the procedure. The changes are written in a different colour. A detailed description of the requirements for each session is to be found in appendix R.2. The changes for Iteration 1B are presented along with the procedure for Iteration 1A.

Introduction (10 min)

One facilitator introduces herself and the other facilitator. Then a facilitator explains how important it is that they do a good job, and that their ideas for toys potential can become real toys. Then, participants write their names, which is followed by a round of telling name and age.

A facilitator then introduces participants to the task of being inventors. They quickly discuss what an inventor is, anda facilitator introduces the icebreaker. This is followed by an introduction to what they will be inventing the next two hours through the video introduction (see section 3.1).

Changes for Iteration 1B:

- Remove the extrinsic motivation initiative, where we state how important it is for us that they do a good job (because they did not care), but keep the other.

Imagineering (10 min)

A facilitator asks children to brainstorm, based on the following: *What could be cool that a futuristic toy could do, if you had the invention*?* A facilitator asks children to raise their hand if they have an idea for a function. Each function is written down on a post-it. Both facilitators note down functions, such that two sets of the same functions are made.

We made no changes for Iteration 1B.

Modelling (40 min)

Children are divided into the two groups. Each group member draws a role by random, and the facilitator presents each role and explains what each role means. Then the groups split up into separate rooms. In each group, the facilitator reads all post-its from Imagineering out loud. Then, each child choose the three coolest functions individually. They take turns reading their favourite functions out loud, and the groups jointly agree on three to five favourite functions. The facilitator explains that they are to build a model, and jointly they draw and describe what they want to build. When they are done drawing, the facilitator unpacks the materials: cardboard, paper, tape, colouring pencils, scissors, straws, ice-lolly sticks, pipe cleaners, yarn, and felt balls. They are now free to build. In the end, groups present their models to each other.

Changes for Iteration 1B:

- Let children discuss the distribution of roles instead of drawing roles randomly (to make the roles important to them), and go through roles once again (to make sure they understand and remember roles).

Activity Generation (30 min)

Each group brainstorms on activities that fit their invented toy, where the facilitator writes ideas for activities on post-its. Then they pick their favourite activity jointly and describe the activity by filling out a card. If there is time left after finishing the first card, they pick the second best activity and fill out another card. Afterwards, groups meet and present their activities to each other.

We made no changes for Iteration 1B.

Retrofit (30 min)

A facilitator presents the hardware followed by some activities of the LEGO BOOST model, Vernie. Then they split up into groups and retrofit by changing the functions and activities to fit existing LEGO BOOST technology. They do this by adding text in another colour on the card. Then groups present their retrofitted activities to each other using the cards.

We made no changes for Iteration 1B.

5.3 Iteration 1 Themes

After conducting the workshop with the above described procedure, we analysed our data using thematic analysis (see section 3.2) and combined it with our evaluation of the outcome. The following is a sum-up of themes from Iteration 1. A thorough description of themes can be found in appendix N. Our qualitative analysis resulted in 7 themes with sub-themes (see figure 5.2). The number sequence of themes is continued from Iteration 1, meaning that the first theme is theme 4.

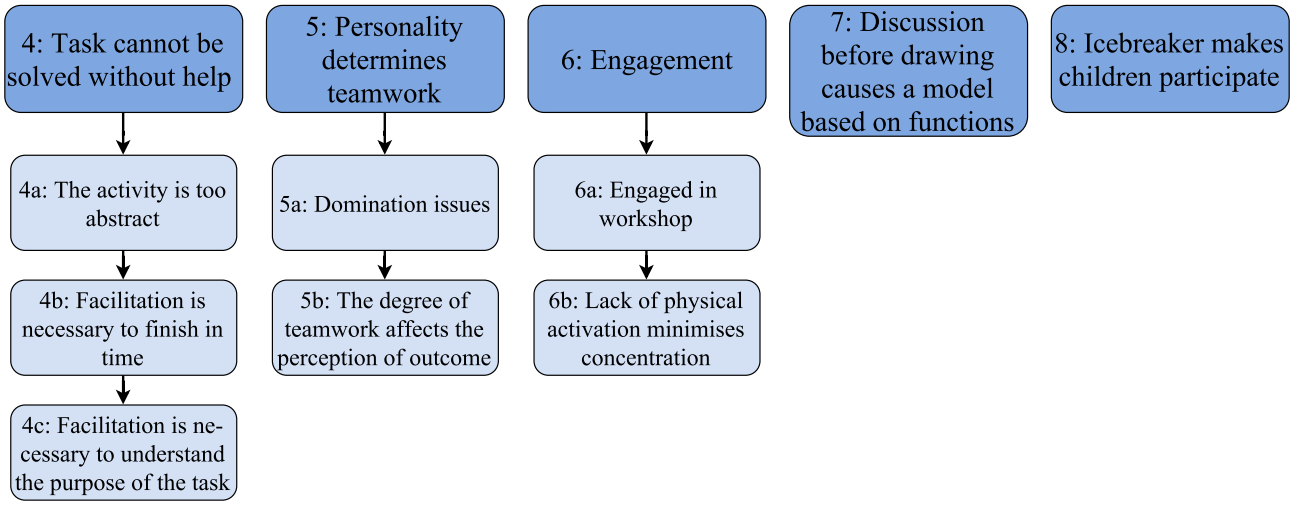


Figure 5.2: Themes from Iteration 1.

Theme 4: Tasks Cannot be Solved Without Help

Some tasks were too hard in order for the children to solve them without help.

The activity is too abstract (sub-theme 4a) for the age group, because the activities were not concerned with what they were familiar with or had at hand. These activities were: to imagine that a toy is fully operative when made in low-tech materials in Modelling, to transform functions into activities in Activity Generation, and to make their future toys and activities fit LEGO BOOST technology in Retrofit. These problems with Retrofit are similar to what we experienced in Baseline.

Facilitation is necessary to finish in time (sub-theme 4b) is evident because the facilitator prompted a lot in Modelling in order to make participants finish the model with all functionality in time. Similar issues about finishing in time were experienced in Baseline, however, these issues are now minor compared to Baseline.

Facilitation is necessary to understand the purpose of the task (sub-theme 4c) was also an issue. First, they had troubles reading, such that the facilitator needed to read and clarify the cards and role-signs in order for them to understand the purpose. Second, children did not fill out the Activity Generation cards sufficiently, as they did not consider what to write before writing, and even though the facilitator prompted them to consider more options, this activity did not add much advancement from the activity brainstorm. Though we still see room for improvements, the Activity Generation cards in combination with the brainstorm have been an improvement compared to Role Play in Baseline. Third, facilitation was needed in order for children to understand that it is an essential part of the task and to remember to include the invention* in tasks, which is similar to Baseline findings.

Theme 5: Personality Determines Teamwork

The personalities within a group determined how well the group worked as a team. For some, it was easy to collaborate, while it was not for other groups.

This is revealed by *domination issues (sub-theme 5a)* in 3 of 4 groups, where the dominating child either acted as a manager or strict oppressor that took ownership of ideas, ignored others' inputs and ideas, and/or created everything alone. The degree and visibility of oppression varied. As a consequence, the non-dominant children reacted by either pleasing the leader and seeking accept, or got frustrated that they were not allowed to contribute. Similar tendencies were found in Baseline.

The degree of teamwork affects the perception of outcome (sub-theme 5b), such that the groups that collaborate ended up satisfied, whereas the groups that did not collaborate ended up unsatisfied. We also experienced a group that was in between. In one group, collaboration was not present due to one group members negative attitude towards teamwork.

Theme 6: Engagement

The children in general had a higher level of engagement compared to Baseline, but lack of physical activation made the concentration drop.

Children were *engaged in workshop (sub-theme 6a)*. They were extrinsically motivated by being told that their toys can end up in stores. We experienced that three groups stuck to the tasks with only few deviations, some started brainstorming ideas even before the introduction was finished, they cared about how their drawings looked, and they were fascinated by Vernie. The high engagement in Modelling was also visible through their remarks.

Yet, *lack of physical activation minimises concentration (sub-theme 6b)*. The lack of physical activation happened when children were cut off from group work, when they should listen, and when they were brainstorming in Activity Generation. Then some children tended to lose their focus and fool around. Still, the concentration issues were reduced compared to Baseline.

Theme 7: Discussion Before Drawing Causes a Model Based on Functions

From this theme it is evident that the drawing worked as a way of getting some groups to base their models on functions, due to the discussions it created. Other groups did not discuss before drawing, and they ended up with a model where they had not thought much of functionality or coherence of their functions and concept of their toy. In addition, the drawing worked well as a basis for the model. This is an improvement since Baseline, where they did not base their model on functions. It also shows the importance of planning.

Theme 8: Icebreaker Makes Children Participate

The icebreaker worked as a means of getting the children comfortable in expressing their minds. In one workshop, we experienced that the first round of the icebreaker was characterised by hesitation in answering, but both groups loosened up in the second round and in Imagineering, which is opposite to what happened Baseline.

When considering all these themes, some findings are similar to what we experienced in Baseline. Yet, we have in general improved the method since Baseline, especially in regards to Modelling and engagement. Yet, there are issues about collaboration and accomplishing the tasks without too much facilitator involvement. In Iteration 2, we will try to solve this.

6 | Iteration 2

In this chapter, we present Iteration 2 and a sum-up of the themes we found. First, we introduce the changes we made, state the new procedure, and end the chapter with a sum-up of the themes we have found by analysing the workshops.

6.1 Changes for Iteration 2

In order to solve the issues experienced in Iteration 1 (see appendix 5.3), we made some initiatives for Iteration 2. These initiatives should deal with all issues found in Iteration 1. In the following, we describe the most crucial changes of the method that ought to solve the most severe issues. A deeper description of changes can be found in appendix O, where a list of all issues is presented as well as argumentation for each initiative.

To act upon the lack of concentration (sub-theme 6b) and negative attitude towards teamwork (sub-theme 5b), we implemented a game-like structure of the workshop to increase intrinsic motivation and physical activation. The game consisted of a board (see figure 6.1) and game cards (see figure 6.2).

Figure 6.1: Front page of board game. It is possible to open each square. Behind each square is a pictogram that matches a board game card.

Figure 6.2: Examples of game cards. One side had a pictogram matching the opened square, and the other side had the task.

The game board resembled an Advent calender, as each square was a door to a sub-task. Behind the door is a pictogram, and the group then had to find the game card with a similar pictogram on the back. The front had an introduction to the sub-task. We believed that the game could be a fun gathering point for the group that led to collaboration and thus dealt with unequal amount of contribution (sub-theme 5a).

Furthermore, the game was an easy way of implementing sub-tasks in the workshop. We used it to implement even more sub-tasks due to their lack of planning in Modelling (theme 7), not implementing functions (theme 7), Apart Together* work (sub-theme 5b), lack of collaboration (sub-theme 5a), and lack of discussion (sub-theme 4c). Thus, the sub-tasks involved planning, elaboration, and decision-making. The planning sub-tasks were implemented prior to the drawing activity, i.e. for planning what toy they were inventing and drawing how the toy could perform each function. Moreover, we implemented sub-tasks coping with the issue of incoherent functions (theme 7). Here, they should brainstorm new functions that fit their toy and choose the final functions to include in the model.

Another initiative for more collaboration, i.e. less Apart Together* work (sub-theme 5b) and equal amount of contribution (sub-theme 5a), was group discussion of what a good teamwork is. Here, we pointed out instances of bad teamwork that we had experienced in previous workshops to let them be aware of avoiding these.

As a help through all sub-tasks and decision-making, we constructed a manuscript of four A3 papers, where all descriptions and drawings of their concept were gathered (see figure 6.3). It had the purpose of ensuring that all worked jointly and agreed what to present in the video presentation.

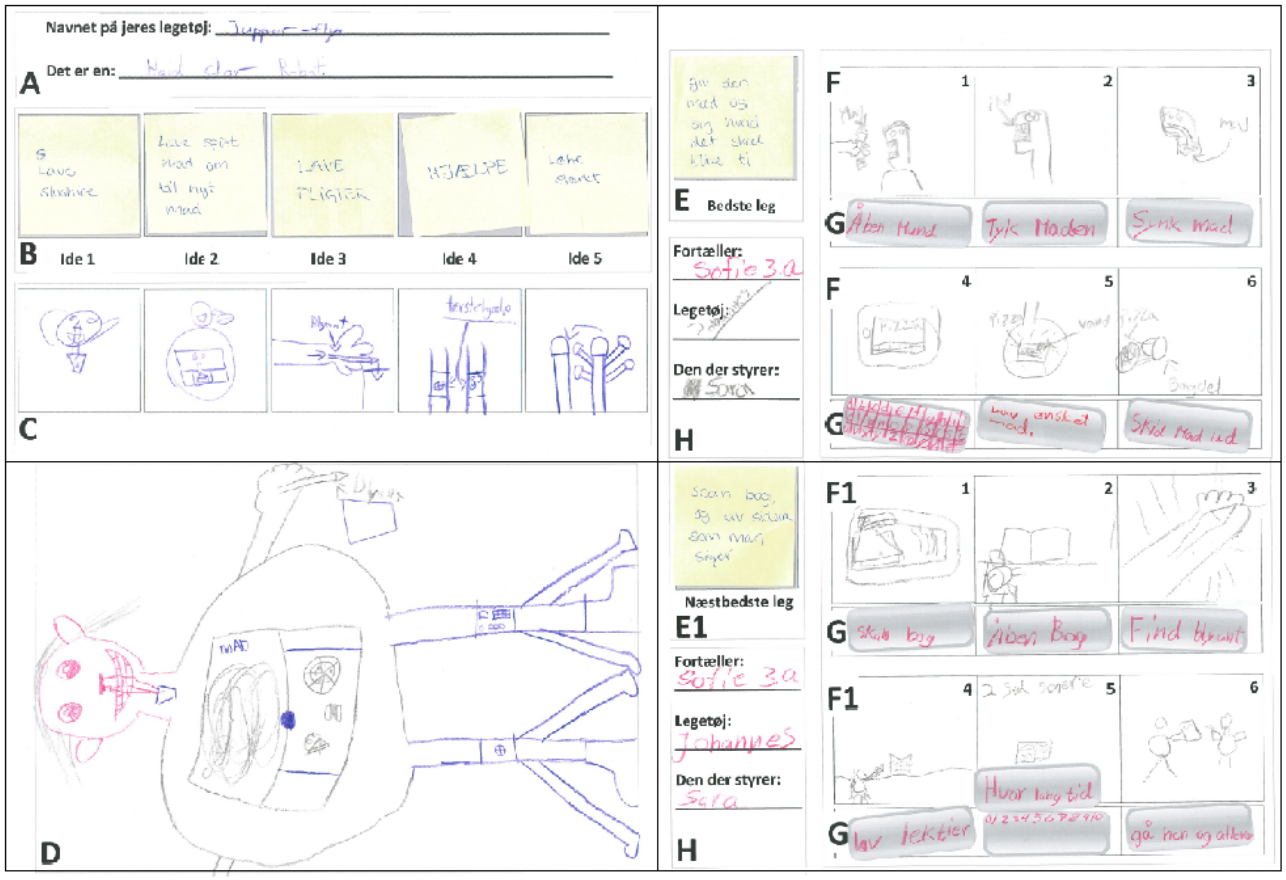


Figure 6.3: Manuscript filled in by Group 10 during the board game.

In Activity Generation, the cards did not make children discuss and elaborate on their chosen activities (sub-theme 4c), making their activities sketchy. Instead, we implemented storyboarding with inspiration from Moraveji et al. (2007) (see appendix G), where children split their activity into sets of scenes. In relation to this, we implemented some retrofit aspects into the storyboarding and removed the Retrofit session, since it was hard to retrofit (sub-theme 4a). We believed that children would make their chosen activities more realistic and tangible by adding buttons for tablet interaction in the different steps of the activity on the storyboard.

To act upon their lack of concentration even more (sub-theme 6b), we implemented an initiative of extrinsic motivation and removed the boredom of listening to the other group presenting by implementing a video recording at the end of the workshop, such that the other group should no longer listen to the presentation. In the video meant for the inventor*, groups were to present the whole play concept, they had invented. We hoped that it would make the scenario about their toys potentially ending in stores, which we introduced in Iteration 1, more real and let them work towards a specific goal.

6.2 Procedure Iteration 2

Based on the prior described changes, we changed the procedure. The elements of the procedure that were not a part of Iteration 1 are written in a different colour. For a description of the outcome requirements of each session, see appendix R. The changes for Iteration 1B are presented along with the procedure for Iteration 1A.

Introduction (10 min)

One facilitator introduces herself and the other facilitator. Children are presented with the purpose of the workshop, i.e. that they are going to invent toys that potentially can end up in stores. Then, all children and facilitators write a name tag followed by a round, where each child and facilitator tell their name and age. A discussion of what an inventor is follows, and then the icebreaker. Afterwards, they are introduced to the design task through the video introduction (see section 3.1). Lastly, the facilitator tells them that the workshop ends with them presenting their toy on video, such that the inventor* gets to know about their invented toys.

We made no changes for Iteration 2B.

Imagineering (10 min)

A facilitator asks children to brainstorm, based on the following: *What could be cool that a futuristic toy could do, if you had the invention*?* Children raise their hands, if they have an idea. The facilitators write down each idea for functionality on a post-it, such that there are two complete sets of ideas.

We made no changes for Iteration 2B.

Modelling (55 min)

Children and facilitator discuss what good and bad teamwork is. Then children are divided into two groups and presented with the different roles by one facilitator. Each group then distributes roles based on who

they believe will be best at a certain role. The roles are then repeated once again, and groups split up in two rooms.

In each group, they are introduced to first part of the board game and the manuscript to fill in. They start playing the game. In this, the facilitator reads all function post-its out loud, and children write down the three coolest functions individually. They tell each other their favourites, and they make a joint decision of which three functions to pursuit. Based on these three functions, they decide a name for their toy and what it is by writing it on the manuscript. They brainstorm further functionality for their toy, where the facilitator writes them down on post-its. Then they pick five functions in total from their previous and newly brainstormed functions and place them on the manuscript.

Afterwards, they make five small descriptions or drawings of how their model should look in order to be able to perform each of these functions. When this sub-task is completed, they gather these 5 drawings or descriptions in one big drawing of the model. After drawing, they check if they have include all five functions in their drawing, and build the model from cardboard, paper, tape, colouring pencils, scissors, straws, ice-lolly sticks, pipe cleaners, yarn, and felt balls. In the end, groups present their models to each other using the model, they have built, and the manuscript.

Changes for Iteration 2B:

- Change wording of the role signs such that they are all 'guards' (because they focussed on the hierarchy of being a guard, general, or captain).
- Change wording on manuscript (because they only wrote down one characteristic of their model in A).
- Change of wording on board game cards (because children had troubles understanding some cards).
- Change of time schedule, such that less time is provided for the Activity Generation brainstorm, and more is provided for the drawing sessions in Modelling (because they had plenty of time for brainstorming, but not enough time for drawing).

Activity Generation (45 min)

The groups are introduced to the second part of the game and start playing. Each group brainstorm on activities with their own model, where the facilitator writes ideas for activities on post-its. Then they pick their favourite activity jointly and place the post-it on the manuscript. Next, they are introduced that the invention* now is a tablet, and they are asked to discuss how their activity takes place step by step using a tablet to control the toy. Then they fill these steps into a storyboard of their activity on the manuscript. Afterwards, they are to figure out which buttons the iPad application needs in order for them to control their toy in the activity. They make the buttons and place them below the storyboard steps they each belong to. If there is time, they pick the second best activity and repeat these steps. In the end, they distribute who presents what, practise their presentation, and present it to the camera, while the facilitator records.

Changes for Iteration 2B:

- Change of wording on board game cards (because children had trouble understanding some cards).
- Change of time schedule, such that less time is provided for the Activity Generation brainstorm, and more is provided for the drawing sessions in Modelling (because they had plenty of time for brainstorming, but not enough time for drawing).
- Remove practise of presentation from board game cards (because it took a long time and was not needed in order for them to present).

6.3 Iteration 2 Themes

After conducting the workshop with the procedure mentioned above, we analysed our data using thematic analysis (see section 3.2) and combined it with our evaluation of the outcome. The following is a sum-up of themes of Iteration 2. A thorough description of themes can be found in appendix P. Our qualitative analysis resulted in 6 themes with sub-themes (see figure 6.4). The number sequence of themes is continued from Baseline and Iteration 1, meaning that the first theme is theme 9.

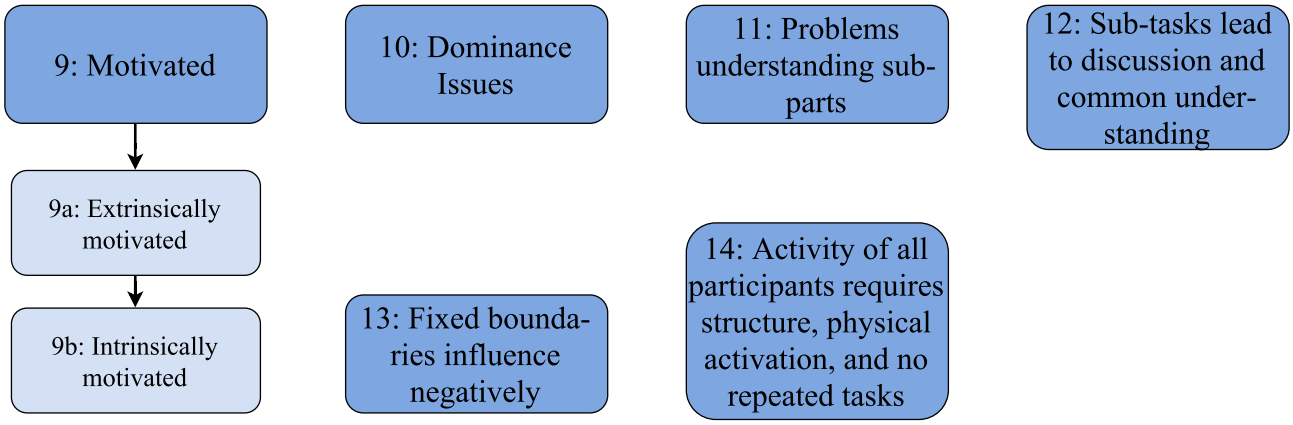


Figure 6.4: Themes from Iteration 2.

Theme 9: Motivated

Through our motivation initiatives, we have managed to heighten children's motivation substantially compared to both Baseline and Iteration 1.

Children were in general *extrinsically motivated (sub-theme 9a)*, meaning that we have managed to motivate all but one child extrinsically by stating that their ideas for a toy potentially can turn into a real toy, which is evident through comments, competitive behaviour between groups, interests in whether the other group had made a proper model, and engagement in own and the other group's presentation. The newly introduced video presentation seem to have heightened the extrinsic motivation compared to Iteration 1, likely because it became more realistic.

Also, children were in general *intrinsically motivated (sub-theme 9b)*, which reveals that our initiatives have worked. Here, we both observed and got comments, which showed that groups were enjoying themselves most of the time in the workshop. Groups were engaged in opening the doors of the board game, and some enjoyed reading the board game cards. In Baseline and Iteration 1, children enjoyed Modelling, while in Iteration 2 the intrinsic motivation was pointed at the workshop as a whole. Yet, only some liked to draw, and if no group member liked to draw, none of them liked the activity.

Theme 10: Dominance Issues

We experienced troubles with dominance in some groups. One instance of dominance was to shoot other's ideas full of holes, because the dominator had a clear idea in his head that he wanted the group to follow, and ideas suggested by others did not cohere with his mental model. A dominator in another group was less strict, as she only dominated occasionally in order to make herself heard. Also, we experienced that

some group members were not really part of the group work. In one case because of a passive nature. In the other case because of being ignored by the two group members, who were close friends.

Theme 11: Problems Understanding Sub-Parts

Throughout the whole workshop, issues with comprehending verbal introductions or introductions on board game cards raised. This is similar to what we have experienced in Baseline and Iteration 1. First of all, Lo-Fi prototypes and tasks caused confusion. Also, they had troubles understanding how they could build a toy in Lo-Fi materials. In addition to the Lo-Fi-issues, they interpreted the roles differently than what we intended. The Activity Generation brainstorm also caused issues. Here, some misunderstood the task, and as a consequence, part of their brainstorm did not result in activities concerned with play. In other occasions, they just added the word 'play' or 'with it' to one of their chosen functions. Similar issues were experienced in Iteration 1. In a few occasions, buttons were not interpreted as paper snippets to draw buttons or text boxes on.

Theme 12: Sub-Tasks Lead to Discussion and Common Understanding

The sub-tasks made the children discuss and agree, such that they arrived at a common understanding of their model and activities, built what they have planned, and felt proud of their model. This is a clear improvement since Iteration 1. These successful sub-tasks were to agree on which toy they were making, to agree on functionality for their toy, discussion before drawing small and big drawings, and agreeing on favourite and second favourite activity. In addition, sub-tasks have led them to focus on functionality rather than looks, which also is an improvement of Baseline and Iteration 1.

Theme 13: Fixed Boundaries Influence Negatively

The many sub-task resulted in very fixed boundaries of the workshop, which sometimes had a negative influence in different ways. First, one child was especially limited by the fixed sequence of tasks and how many ideas they were able choose for their toy, such that the group did not manage to include all of his ideas. Second, the long manuscript seemed overwhelming to some. Third, time was a limiting factor, as some groups had troubles finishing within the time limit.

Theme 14: Activation of All Participants Requires Structure, Physical Involvement, and No Repeated Tasks

In order for all participants to take part in the tasks, the tasks needed to be both structured, involve physical activation, and be new rather than repeated tasks. The building part of Modelling was too unstructured for the children to stay focussed, and the second round of Activity Generation was boring, because of repeated tasks and no need for physical activation of all group members when doing the storyboard. Thus, some elements made participants do Laughing Out Loud* or Free Ride*. However, it is still a clear improvement from Baseline and Iteration 1.

These themes show that we have improved the applied method when comparing it to Baseline and Iteration 1. Still, it has introduced some new issues concerning the new structure of the workshop. Nevertheless, the improvements are clear in regards to accomplishing tasks and motivation. In the following chapter, we present the general improvement we have made through all three iterations.

7 | Progress in Iterations

In this chapter, we sum up how our issues progressed as well as whether our outcome requirements were fulfilled. The actual evaluation of outcome requirements can be found in appendix R. Furthermore, the evolvement of issues is a sum-up of issues stated in appendix M, O, and Q.

7.1 Progress in Issues

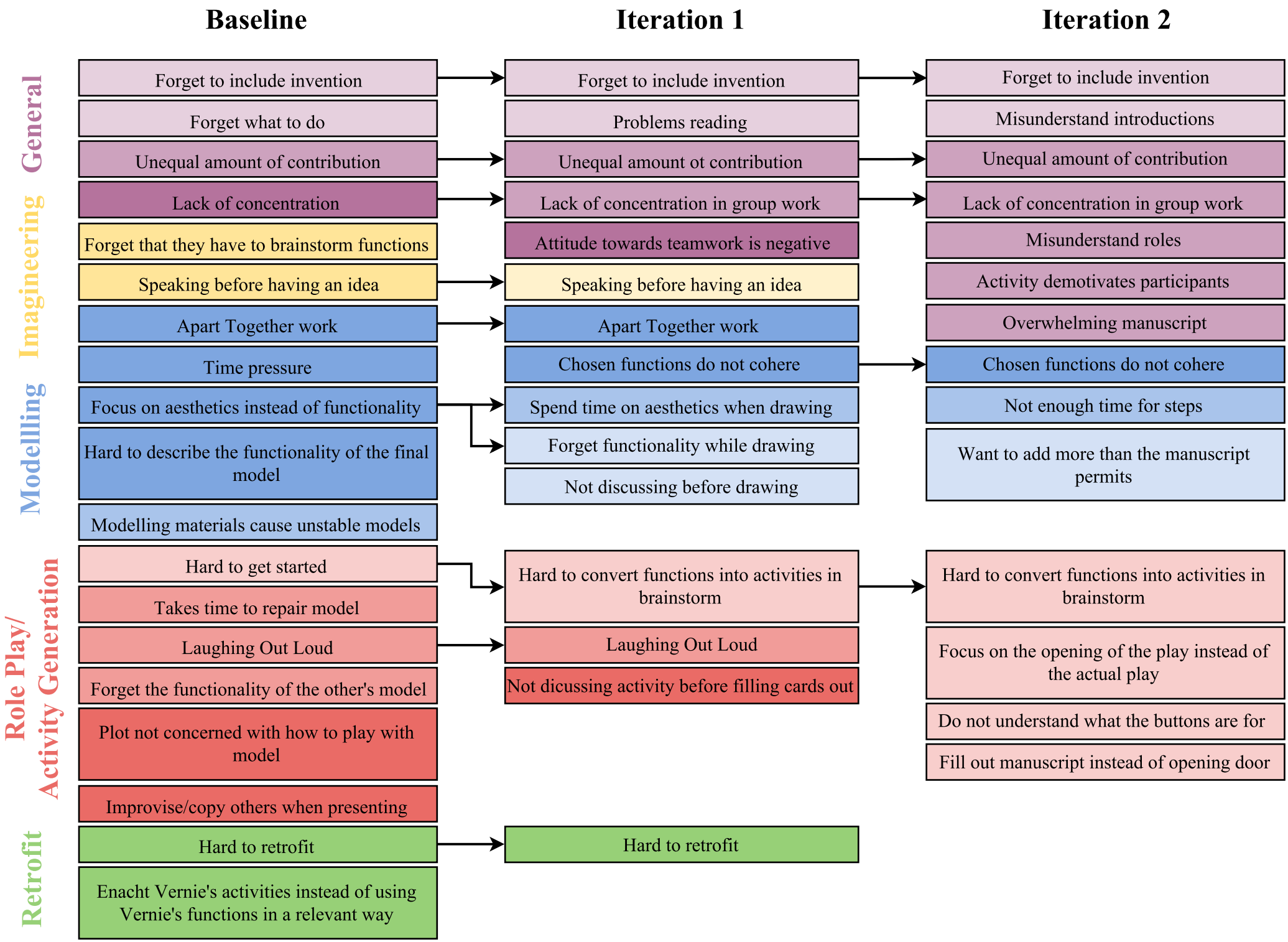
On the next page is a full overview of the issues we experienced in the workshops and how they evolved. Each rectangle is an issue. The arrows show, if issues are passed on to the next iteration, and the colours show in which session of the workshop the issue was experienced. The graduation of the colour represent the severity of the issues, where the darkest colour represents severity score 3 (highest severity), the lighter represents severity score 2 (medium severity), and the lightest graduation represents severity score 1 (lowest severity). The two yellow graduations represents severity score 2 and 1, and the green rectangles all represent a severity score of 3.

When examining the progress of issues, we see that the number of issues has decreased from Baseline to Iteration 2. We ended up only having one issue with a severity score of 3 which is the issue 'chosen functions do not cohere', which is essential to solve before applying the method, as this issue affects the outcome directly.

Especially in Role Play/Activity Generation we see an improvement. Changing this session from a role play to brainstorming and storyboarding has improved the suitability and capability of the Facilitated Design* method. Now, the issues for Activity Generation only concerns how the tasks are introduced and facilitated.

Also, there are clear improvements in the remaining sessions as well as the method in general. In Imagineering, we have removed all issues through facilitation initiatives rather than larger changes of the method. In Modelling, we have managed to move from Apart Together* work and a focus on aesthetics in Baseline, to teamwork and a focus on functionality in Iteration 2. Regarding issues general to the method, we see that we have increased the number of general issues due to the structure of Iteration 2. Yet, these issues are small.

In total, the number of issues have evolved from being 19 in Baseline to being 15 in Iteration 1 and 14 in Iteration 2. Also, when calculating the average severity of each issue, we see that it has decreased from 2.3 in Baseline to 1.9 in Iteration 1 to 1.6 in Iteration 2. This indicates that the method of Iteration 2 is more suitable to children and make them capable of creating more useful outcomes.


Baseline
Iteration 1
Iteration 2
General
Imagineering
Modelling
Role Play/ Activity Generation
Retrofit
Forget to include invention
Forget what to do
Unequal amount of contribution
Lack of concentration
Forget that they have to brainstorm functions
Speaking before having an idea
Apart Together work
Time pressure
Focus on aesthetics instead of functionality
Hard to describe the functionality of the final model
Modelling materials cause unstable models
Hard to get started
Takes time to repair model
Laughing Out Loud
Forget the functionality of the other's model
Plot not concerned with how to play with model
Improvise/copy others when presenting
Hard to retrofit
Enacht Vernie's activities instead of using Vernie's functions in a relevant way
Forget to include invention
Problems reading
Unequal amount ot contribution
Lack of concentration in group work
Attitude towards teamwork is negative
Speaking before having an idea
Apart Together work
Chosen functions do not cohere
Spend time on aesthetics when drawing
Forget functionality while drawing
Not discussing before drawing
Hard to convert functions into activities in brainstorm
Laughing Out Loud
Not dicussing activity before filling cards out
Hard to retrofit
Forget to include invention
Misunderstand introductions
Unequal amount of contribution
Lack of concentration in group work
Misunderstand roles
Activity demotivates participants
Overwhelming manuscript
Chosen functions do not cohere
Not enough time for steps
Want to add more than the manuscript permits
Hard to convert functions into activities in brainstorm
Focus on the opening of the play instead of the actual play
Do not understand what the buttons are for
Fill out manuscript instead of opening door

7.2 Improvement of Outcome

The evaluation of the outcome was a part of the thematic analysis. Still it is interesting to examine the progress of requirements, as this reveals which parts of the Facilitated Design* method we have improved. Table 7.1 shows how the fulfilment of requirements has developed. We see a clear progress on some requirements, while others remain the same. This also means that Iteration 2 fulfils some requirements, but not all.

Some requirements that were not fulfilled in Baseline have come closer to fulfilment through Iteration 1 and 2. For instance, children did not fulfil the requirements 'able to present model and functions', 'able to present activity(ies) based on functions', and 'use invention/tablet in presentation' in Baseline. It became better in Iteration 1, probably due to the drawing and the Activity Generation cards, but still, some groups had issues with presenting their play concept. In Iteration 2, these issues were eliminated as all groups succeeded in presenting both model and play concept, and used the invention as part of their activities. It has most likely been due to the manuscript that visualised decisions and activities, and due to sub-tasks implemented in the board game. Yet, in none of our workshops have children managed to fulfil the requirement 'use invention in presentation' in Modelling.

The initiatives, we made when trying to achieve 'advancement from activity brainstorm', have also shown their effects on the outcome, as this requirement is almost fulfilled by all groups in Iteration 2, whereas no group completely fulfilled this requirement in Iteration 1. Here, the storyboard had a positive effect, likely because it made the children break their activities into steps in a structured way, which the cards in Iteration 1 did not. Yet, there were still minor issues with the storyboard as the requirement 'create buttons as intended' was not completely fulfilled, due to misunderstood introductions.

The requirements 'drawing/description of model and functions' and 'model with all functions' have most likely moved closer to fulfilment because of the sub-tasks in Iteration 2 about drawing/describing each chosen function. This sub-tasks was not a part of Iteration 1, and it has shown its effect through this requirement.

All of this shows that the drawings, manuscript, storyboard, and division into sub-tasks have successfully improved the outcome. Yet, one requirement that we have not yet managed to fulfil is 'coherent functions for their toy'. This requirement is linked to the issue of chosen functions not cohering, which has a severity score of 3. Thus, our method have not been sufficient to ensure an outcome with coherence.

Also, the method has not been sufficient to ensure novelty. As table 7.1 shows, the novelty requirements have not been fulfilled. Through the iterations, we have not made any new initiatives in order to deal with the lack of novelty of brainstorm ideas, as this analysis is a based on similarities with ideas from all iterations, and thus we have first become aware of the issue after Iteration 2 (see appendix R.3). Because of the missing novelty in functionality brainstorms, children have not developed many novel play concepts either.

Summing up, our main initiatives for Iteration 2 have positively affected the outcome. These initiatives are the elements of the board game, i.e. manuscript, drawings/descriptions, and storyboard. Yet, there are still some requirements to the outcome that have not been fulfilled, especially in regards to novelty and coherence.

	Outcome Requirements	Baseline				Iteration 1				Iteration 2			
		1	2	3	4	5	6	7	8	9	10	11	12
Imagi-neering	Brainstormed ideas are novel	X	÷	÷	÷	÷	÷	÷	÷	÷	÷	÷	÷
Modelling	Coherent functions for their toy	÷	X	÷	÷	✓	(✓)	(✓)	(✓)	(✓)	(✓)	÷	(✓)
	Brainstormed functions are novel									÷	÷	÷	(✓)
	Drawing/description of model and functions					✓	÷	(✓)	(✓)	(✓)	✓	✓	(✓)
	Model with all functions	(✓)	✓	÷	✓	✓	÷	(✓)	✓	(✓)	✓	(✓)	(✓)
	Chosen functions for model are novel	÷	÷	÷	(✓)	÷	÷	÷	÷	÷	(✓)	(✓)	(✓)
	Developed concept of model is novel	X	X	X	X	(✓)	X	÷	X	÷	÷	(✓)	÷
	Details of appearance in model are novel	X	÷	÷	÷	÷	X	÷	÷	÷	÷	÷	÷
	Description of finished model	✓	✓	✓	✓								
	Able to present model and functions	÷	✓	÷	✓	✓	÷	✓	÷	✓	✓	✓	✓
	Use invention in presentation	÷	÷	÷	÷	÷	÷	÷	÷	÷	÷	÷	÷
Role Play/ Activity Generation	Brainstormed activities are novel					(✓)	(✓)	÷	(✓)	÷	÷	(✓)	÷
	Advancement from activity brainstorm					÷	(✓)	÷	÷	(✓)	✓	✓	✓
	Create buttons as intended									÷	(✓)	(✓)	(✓)
	Able to present activity(-ies) based on functions	÷	÷	✓	÷	(✓)	✓	÷	✓	✓	✓	✓	✓
	Use invention/tablet in presentation	÷	÷	✓	✓	✓	(✓)	✓	÷	✓	✓	✓	✓
Retrofit	Able to present their retrofitted activity(ies)	(✓)	÷	÷	÷	÷	÷	(✓)	✓				
	Use tablet in presentation	÷	✓	÷	✓	✓	(✓)	✓	÷				

Table 7.1: Comparison of outcomes across group's different play concepts. The numbers refer to each developed play concept. As the outcome requirements differed between iterations, an empty cell means that it has not been a requirement in that particular iteration. ✓= fulfils outcome requirement, ÷ = does not fulfil outcome requirement, (✓) = at least half of the outcome fulfils the requirement, X = not possible to evaluate requirement based on outcome.

8 | Discussion of Facilitated Design Method

In the following, we discuss the essential elements in developing a design method suitable to children that make them capable of developing useful outcomes. A discussion of remaining issues, our analysis method, constrains, motivation, group composition, and a comparison to Read et al. (2002)'s issues can be found in appendix T along with general guidelines for conducting Facilitated Design* with our target group.

8.1 Process and Outcome Analysis

Researchers, who are against analysing the process of design methods, argue that is complex to compare observations with psychological models (Shah et al., 2003). Yet, we have demonstrated that it has been possible to compare observations with theory such as motivation and collaboration, which has given rich information about why children behave as they do.

Furthermore, we have found that when evaluating the outcome of each session and comparing this with the process, it reveals how suitability and capability are connected. Evaluation of process and outcome supplement each other and when developing a design method for children, and it is insufficient to only evaluate outcome or process. The process analysis pinpoints the issues that must be improved, and the outcome evaluation reveals whether the improvement has resulted in a more useful outcome. In this way, our improvements of the workshop by solving suitability issues heightened the capability. When the industry applies the method in order to develop design solutions, it is primarily the outcome which is interesting. Yet, information about suitability have revealed to us as researchers what elements of the workshop to improve.

8.2 Target Group

As mentioned in section 2.2, we wished to develop a method for doing Facilitated Design* with 8-9 year old children. Therefore, we asked schools for this age group, however, schools also gave us 10 year old children (see section 3.1). More precisely, the school used in Baseline provided a mixture of second and third graders, the school used in Iteration 1 only second graders, and the school used in Iteration 2 only third graders. This meant that in Iteration 2, none of the children were 8 year old. Instead, seven of the children were 9 years old, and five of the children were 10 years old. Based on this, we do not know whether Iteration 2 is suitable for 8 year old children, because of the rapid changes in information processing speed in this age range, meaning that a 10 year old might be very different than an 8 year old in accomplishing the tasks we set up in the workshop (see appendix B.2). Thus, this needs to be verified in a new evaluation of the method. A learning from this is to ask for one year (e.g. second graders) instead of an age-range (e.g. 8-9 year old pupils) when contacting schools.

Another aspect to consider is individual differences. Piaget argues that cognitive development is dependent on age, while the neo-Piagetian theory stresses that individual differences in information processing affects when children will obtain the next developmental stage (see appendix B). Based on neo-Piagetian theory, our method might not be suited for all 9 year old children, because of individual differences. However, as the theory of Cooperative Learning states, effective group work requires that participants work together towards the same goal, which only happens when they arrive at a shared understanding, i.e. when they

reach intersubjectivity (see appendix H.1.1). In order to reach this shared understanding, one child will act as a tutor for peers and scaffold. Thus, scaffolding by peers might minimise the effect that individual differences have when doing group work.

Apart from these individual differences, also cultural aspects can affect suitability of the method. We assume that cognitive development is invariant across different cultures. Yet, power relations might be different in other cultures. In Danish schools, the teacher is a chairman, tutor, or consultant, and the pupil does not have to agree with the teacher (Print et al., 2002). Thus, adult-child power relations in a school-context might be weaker in Denmark than in other cultures, which is important to consider, when applying our method. As another example, Danish children might not be inhibited to propose silly ideas to adults in a brainstorm, while children of other cultures might be afraid of coming with incorrect ideas, which is the case in e.g. China (Flowerdew, 1998). Thus, it is important to provide an environment where children do not feel inhibited to only provide answers that they are completely sure are correct (Flowerdew, 1998).

Our method ensures that children down to the age of 9 are able to accomplish tasks. Yet, we also believe that our main parts of our method are applicable for children older than 10. Maybe some initiatives will not work as well on children at the formal operational stage (11+ years old), such as taking the collaboration roles seriously and having them believe that the actor in the video introduction is a real inventor. Also, this age group seems to be concerned with how things are supposed to be (Druin et al., 1998), which might make them think of less unique solutions. Furthermore, some sub-tasks about planning and discussing might be superfluous, because these come natural to them due to their higher developmental level of planning skills (see appendix B.2.3), and hence can be skipped. Still, because the target group will have a higher cognitive level, they ought to be able to perform all tasks that a younger target group can perform, and thus it will not induce the need for creating other sub-tasks. In sum, it is merely motivation and teamwork initiatives that must be reconsidered.

8.3 Does Our Method Fit Facilitated Design?

We did not fully succeed in developing a Facilitated Design* method for 9-10 year old children, as we still have some capability issues. Yet, we have managed to develop a method that is suitable to this age group.

The method is suitable, because we in Iteration 2 managed to keep the adult role mostly as Facilitator* (sometimes Motivator*) and never Participant*. This is someone who clarifies instructions, ensures that they accomplish the task before moving on to the next task, and sometimes motivates them. We have been able to develop tasks and an environment that make children evaluate, discuss, make joint decisions, agree, stay motivated and accomplish tasks. These listed elements are essential when making the method suit children. Therefore, they must all be considered when conducting design workshops with children, as they are not a matter of course.

Yet, there are still three major issues we have not solved regarding capability. First, it has been an issue through Iteration 1 and 2 that children choose incoherent functions (theme 7 and 10). Instead of choosing functions that make sense to one toy, children want their toy to be able to do as many cool things as possible. This issue can also be caused by them cognitively not being able to combine many functions, because of their underdeveloped information processing skills (see appendix B.2). This is also evident in their activities, as children do not brainstorm activities that involve many functions (see appendix R.4). Second, when analysing the novelty of their models (see table 7.1), we see that children developed similar toys when using the method. Here, they often came up with common concepts and details for the toys (e.g. robot with legs, arms, and a face). This might be caused by the type of constraints the method contains, which makes it hard to be creative (see appendix T.2 for a discussion of this). Third, another capability issue is their lack of ability to retrofit ideas to fit existing technology, and without any retrofit of their play

concepts, they are not directly realisable. A thought could be that brainstorming non-futuristic functions in Imagineering would be a solution, such that they ended up with non-futuristic concepts that do not need a retrofit. Yet, the risk of developing common play concepts and not new and disruptive play concept is high (Vavoula and Sharples, 2007). Also, Guha et al. (2013) have experienced that though children are convinced that their ideas can be implemented with current technology, many ideas are actually completely unworkable technically. Therefore, it is not a solution, meaning that we still recommend that children brainstorm futuristic functions, and the designers do the retrofit. These three issues show that we still need to deal with some issues, before we have managed to develop a Facilitated Design* method, where children as designers will be able to work their way from idea to implementable and useful concept.

As the method is now, children cannot act as sole designers in Facilitated Design*. Instead, children can take the role as informants* with our method. This means that rather than implementing children's play concepts directly, they should be used as input to the design process, where design experts make design decisions on the basis of children's play concepts. Here, it requires a deeper analysis and interpretation for design experts to translate them into design concepts (Mazzone et al., 2012), e.g. develop a cooking chef, because children like the idea of it making food or candy. To find the interesting parts of children's ideas, it is important to look at the underlying truths behind these ideas, e.g. asking yourself why the children wanted to be able to teleport (Guha et al., 2013). Our method makes it easy for design experts to drag out ideas from a workshop, as the relevant aspects (i.e. concepts including name, characteristics, functions, looks, and their favourite activities) are visible on the manuscript and presented in a video recording in the end of the workshop. Here, is it important that the facilitator ensures that they present their full play concept.

Summing up, the outcome of the method is not yet directly applicable for creating concepts for toys. Therefore, children should be used as informants*, not designers, with our method. For future work, it would be interesting to investigate how it is possible to add/change tasks in our Facilitated Design* method to cope with these problems without decreasing the suitability of the method. If the outcome issues are solved, children can be used as designers in Facilitated Design*.

8.4 Generalisation

Our developed method is applicable in other cases of interaction-based technology. Hence, a tablet does not necessarily have to be a part of the play concept. Regarding the buttons for the storyboard, it would be possible to modify this sub-task to be concerned with buttons on the toy or other interface elements. Alternatively, this sub-task can be skipped. Also, our method is applicable when developing a digital game. Here, the brainstorm probably need to be restricted to which type of game it should be (strategic game, racing game, etc.) to get creative ideas of what functions the game should have. In the remaining session, our method will be directly applicable, when changing the wording from concerning toys to games.

Less technological toys (e.g. dolls or cars) could also be developed with our method. The only requirement is interaction, as many tasks are based on interactions (e.g. function brainstorm and storyboarding). The brainstorm of functions should be based on what the child would like to do with the toy and not what the toy would be able to do. Here, it is important not to mix functions and activities, but still keep them separated for various tasks in the workshop. In addition, when applying our method on less technological products, the retrofit issues, we experienced, may not be present, because children will not need to know what is realistic technologically. Thus, for less technological toys, it may be possible to push children in direction of being designers in Facilitated Design*.

Yet, our method is limited to developing entertainment products and not educational products. When working with children on educational products, Scaife and Rogers (1999) as well as Guha et al. (2013)

argue that many ideas go against the learning goals of the product. Moreover, Scaife et al. (1997) argue that in a learning context, children cannot design their own learning goals, for which reason inputs from teachers, psychologists and educational technologists can be valuable. Thus, we do not recommend designing educational products using our method.

Based on this discussion as well as our discussion in appendix T, we recommend a method for involving children as designers in Facilitated Design*, which we present in the following chapter.

9 | Recommended Method: Playful Design

Playful Design

Introduction (10 min)

- ”What you will invent today can potentially end up in stores”
- Do a presentation of name and age by children and facilitators
- Discuss: ”What is an inventor?”
- Run the icebreaker Tall Stories (Knox, 2012)
- Present design task in video using Obstructed Theatre (Read et al., 2010)
- ”In the end, you will make a video presentation of your product for an important person”

Imagineering (10 min)

- In relation to the design task, conduct a brainstorm on functions that would be cool a future product could do

Sketching (55 min)

- Discuss: ”What is good teamwork?”
- Present teamwork certificate that they can earn
- Create groups and let children distribute accountability roles: seriousness, everyone-decide, and collaboration guard
- Let groups play board game, where they:
  - 1) Individually note down three favourite functions, 2) present to the group, 3) decide on one main function
  - 1) Individually ideate on an product, 2) present to the group, 3) decide on an product
  - 1) Decide on name and characteristics, 2) brainstorm sub-functions, 3) pick two sub-functions
  - 1) Describe/draw implementation of the three functions, 2) gather functions in one drawing, 3) check that all functions are included 4) add extra functions or details
- Let groups present designed product concept to each other

Activity Generation (45 min)

- Let groups continue the board game, where they:
  - 1) Brainstorm activities with their product
  - 1) Pick funniest activity, 2) discuss steps of activity, 3) draw steps in storyboard, 4) make interactive (e.g. buttons) elements in relation to storyboard steps
  - 1) Pick second funniest activity, 2) discuss steps of activity, 3) draw steps in storyboard, 4) make interface elements in relation to storyboard steps
- Let groups present designed product and activities on a video, which is for an important person

9.1 Guidelines for Playful Design

Based on our discussion in chapter 8 and appendix T, we propose the following guidelines for conducting Playful Design with children aged 9 and above. These guidelines are connected to the procedure of Playful Design. More guidelines for conducting design workshops with children in can be found in appendix T, where these are targeted design workshops with children in general.

Playful Design

Facilitator role

- If children incite the facilitator to make a decision, then deny to avoid influencing results.
- Separate groups in different rooms with one facilitator in each to avoid cognitive tuning (Fern, 2001, p. 104). In addition, this makes it possible to ask questions at all times.
- Use a manuscript to visualise decisions and use it when children present their product concept and activities in the video at the end of the workshop. Attach only one page of the manuscript at the time to avoid children being overwhelmed by the number of tasks.

Initiation of workshop

- If children have invented concepts prior to the workshop, tell them to explain these ideas after the workshop has ended, both to ensure that they develop new ideas, but also to benefit from their prior ideas.

Collaboration

- Make groups of 3 children of same gender. Personality, interests, and energy level should also be taken into account. Ask an adult, who knows the participating children, how groups should be composed.
- Think about how children are seated: if one child is left out of group work, let this child sit in the middle, and if two children tend to fool around together, then let the third child sit in the middle.

Conducting the workshop sessions

- In Imagineering, make sure children raise their hands, if they have an idea, to ensure that children do not speak before having a deliberate idea.
- During the board game, let children choose who should read the board game cards - children or facilitator. Some children like to read, while others would rather not read.
- In Sketching, let facilitators read post-its out loud to ensure children consider all Imagineering functions.
- In Activity Generation, if there is lack of motivation to draw, let children know that they can have the facilitator draw what they tell.

10 | Conclusion

We strived to develop a method for using 8-9 year old children in the generative phases of a design process in a way that was realistic to the industry, where resources are limited. In addition, the method should ensure that children's desires were expressed in the resulting toy. Based on this, we attempted to develop a Facilitated Design* method that ensured high suitability and capability, because to our knowledge, such a method did not exist for this target group. We took our starting point in the Future Technology Workshop by Vavoula and Sharples (2007), and iterated on method improvements in order to reach high suitability and capability for our target group. We recruited children through schools and ended up testing iterations of the method on a total of 37 children aged 8-10. In our last iteration, only 9-10 year old children participated, meaning that we have only tested our resulting method on this age group.

Our resulting method, Playful Design, consists of three sessions: Imagineering, Sketching, and Activity Generation. In Imagineering, the participating children brainstorm functions for future products in plenum. In Sketching, children are split into two groups, where they choose functions and characteristics, and draw their product. In Activity Generation, groups brainstorm on activities with their invented product, develop storyboards that shows the steps of their chosen activities, and add interface elements for interaction with their product. A board game guides children through Sketching and Activity Generation.

With our resulting method, we succeeded in creating a Facilitated Design* method with high suitability for 9-10 year old children by primarily implementing scaffolding techniques, visualisation of decisions, as well as extrinsic and intrinsic motivation initiatives. Likewise, we experienced improvements by implementing drawings to develop a product and storyboards to develop activities for playing with the product. We have demonstrated that splitting tasks into sub-tasks make it easier for the target group to accomplish tasks, that stating the importance of their contributions in the design process heightens extrinsic motivation, and that a game-like structure of the design workshop is enough to achieve an association with fun and thus obtain intrinsic motivation. Yet, we did not manage to solve all experienced capability issues, as parts of the outcome created by children was insufficient. In relation to this, children's chosen product functions and characteristics were not sufficiently coherent, their products were rather obvious, and children did not manage to make their play concepts fit existing technology. In total, this means that it becomes the design expert's job to examine underlying truths and interesting aspects of children's play concepts as well as make them feasible with existing technology. Therefore, as long as these issues are not solved, children should only be used as informants* with our method, i.e. they should inform the design decisions made by design experts, and not be used as sole designers in Facilitated Design.

In addition to development of a method, we have demonstrated that it is essential to both evaluate process and outcome when developing a design method for children. Here, the process evaluation revealed what to improve, and the outcome evaluation revealed whether attempts of improvements were successful.

Bibliography

Amabile, T. M. (1983). The social psychology of creativity: A componential conceptualization. *Journal of personality and social psychology*, 45(2):357. v, 55, 56, 106, 107, 117

Bartfay, W. J. and Bartfay, E. (1994). Promoting health in schools through a board game. *Western journal of nursing research*, 16(4):438–446. 57

Beaudouin-Lafon, M. and Mackay, W. (2003). Prototyping tools and techniques. *Human Computer Interaction-Development Process*, pages 122–142. 48

Benson, J. B. (1997). The development of planning: It's about time. *The developmental psychology of planning: Why, how, and when do we plan*, pages 43–75. 52, 92

Benton, L. and Johnson, H. (2014). Structured approaches to participatory design for children: can targeting the needs of children with autism provide benefits for a broader child population? *Instructional Science*, 42(1):47–65. 9, 71, 72, 74

Berk, L. E. (2013). *Child Development*. Upper Saddle River, N.J.: Pearson, 9 ed. edition. 50, 51

Berk, L. E. and Winsler, A. (1995). *Scaffolding Children's Learning: Vygotsky and Early Childhood Education. NAEYC Research into Practice Series. Volume 7.* ERIC. 54, 64, 65

Blair, C., Zelazo, P. D., and Greenberg, M. T. (2005). The measurement of executive function in early childhood. *Developmental neuropsychology*, 28(2):561–571. 52

Bødker, S. (1996). Creating conditions for participation: Conflicts and resources in systems development. *Human-computer interaction*, 11(3):215–236. 48

Brandt, E. and Messeter, J. (2004). Facilitating collaboration through design games. In *Proceedings of the eighth conference on Participatory design: Artful integration: interweaving media, materials and practices - Volume 1*, pages 121–131. ACM. 57

Braun, V. and Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, 3(2):77–101. 9, 71

Bruckman, A., Bandlow, A., and Forte, A. (2008). Hci for kids. *Handbook of Human-Computer Interaction, J. Jacko and A. Sears, Ed. Lawrence Erlbaum Associates*, pages 793–809. 1, 2, 50

Bruckman, A., Bandlow, A., and Forte, A. (2012). *Human computer interaction handbook: Fundamentals, evolving technologies, and emerging applications.*, chapter HCI for kids, pages 793–809. CRC press. 50

Burman, D. D., Bitan, T., and Booth, J. R. (2008). Sex differences in neural processing of language among children. *Neuropsychologia*, 46(5):1349–1362. 154

Camos, V. and Barrouillet, P. (2011). Developmental change in working memory strategies: from passive maintenance to active refreshing. *Developmental psychology*, 47(3):898. 52

Case, R. (1996). *The role of central conceptual structures in the development of children's thought*, chapter Introduction: Reconceptualizing the nature of children's conceptual structures and their development in middle childhood, pages 1–26. Monographs of the society for research in child development. 51

Csikszentmihalyi, M. (1996). Flow and the psychology of discovery and invention. *New York: Harper Collins*. 56, 107

Damon, W. (1984). Peer education: The untapped potential. *Journal of applied developmental psychology*, 5(4):331–343. 65

Davis, A. and Jones, L. (1996). Environmental constraints on health: Listening to children's views. *Health Education Journal*, 55(4):363–374. 66, 79

Dawson, P. and Guare, R. (2010). *Executive skills in children and adolescents: A practical guide to assessment and intervention*. Guilford Press. 6, 52, 53, 81

Druin, A. (1999). Cooperative inquiry: Developing new technologies for children with children. In *Proceedings of the SIGCHI conference on Human Factors in Computing Systems*, pages 592–599. ACM. 61, 62

Druin, A. (2002). The role of children in the design of new technology. *Behaviour and Information Technology*, 21(1):1–25. 1, 3, 48, 49, 149

Druin, A., Bederson, B., Boltman, A., Miura, A., Knotts-Callahan, D., and Platt, M. (1998). Children as our technology design partners. *The design of children's technology*, pages 51–72. 3, 32, 61, 62, 67

Druin, A., Stewart, J., Proft, D., Bederson, B., and Hollan, J. (1997). Kidpad: A design collaboration between children, technologists, and educators. In *Proceedings of the ACM SIGCHI Conference on Human factors in computing systems*, pages 463–470. ACM. 1, 71

Fails, J. A., Guha, M. L., Druin, A., et al. (2013). Methods and techniques for involving children in the design of new technology for children. *Foundations and Trends in Human–Computer Interaction*, 6(2):85–166. 60

Fern, E. F. (1982). The use of focus groups for idea generation: The effects of group size, acquaintanceship, and moderator on response quantity and quality. *Journal of marketing Research*, pages 1–13. 64

Fern, E. F. (2001). *Advanced Focus Group Research*. Sage. 8, 36, 69, 77, 150

Flowerdew, L. (1998). A cultural perspective on group work. *ELT journal*, 52(4):323–329. 32

Fogh, R. (2017). Internal communication. Information from meeting with LEGO BOOST representative in Billund the 28th of February 2017. 58

Fyfe, B. (1985). Encouraging creative thinking in children. *Teacher Education Quarterly*, pages 30–35. 8, 56, 67, 104

Gelderblom, H. and Kotzé, P. (2009). Ten design lessons from the literature on child development and children's use of technology. In *Proceedings of the 8th International Conference on Interaction Design and Children*, pages 52–60. ACM. 1

Gómez-Pérez, E. and Ostrosky-Solís, F. (2006). Attention and memory evaluation across the life span: heterogeneous effects of age and education. *Journal of Clinical and Experimental Neuropsychology*, 28(4):477–494. 51

Guha, M. L., Druin, A., Chipman, G., Fails, J. A., Simms, S., and Farber, A. (2004). Mixing ideas: A new technique for working with young children as design partners. In *Proceedings of the 2004 conference on Interaction design and children: building a community*, pages 35–42. ACM. 74

Guha, M. L., Druin, A., and Fails, J. A. (2013). Cooperative inquiry revisited: Reflections of the past and guidelines for the future of intergenerational co-design. *International Journal of Child-Computer Interaction*, 1(1):14–23. 1, 3, 33, 49, 74, 149

Hanna, L., Risden, K., and Alexander, K. (1997). Guidelines for usability testing with children. *Interactions*, 4(5):9–14. 15, 67, 72, 86

Heary, C. M. and Hennessy, E. (2002). The use of focus group interviews in pediatric health care research. *Journal of pediatric psychology*, 27(1):47–57. 8, 64, 73

Hemmert, F., Hamann, S., Löwe, M., Zeipelt, J., and Joost, G. (2010). Co-designing with children: a comparison of embodied and disembodied sketching techniques in the design of child age communication devices. In *Proceedings of the 9th International Conference on Interaction Design and Children*, pages 202–205. ACM. 60

Ihlström, C., Svensson, J., and Åkesson, M. (2005). Participatory design of future every day it artifacts-engaging readers and publishers in designing the e-newspaper. In *Proceedings of the 28th Information Systems Research Seminar in Scandinavia*. 12, 75

Kafai, Y. B. (1996). Software by kids for kids. *Communications of the ACM*, 39(4):38–39. 5, 63

Kafai, Y. B. (1998). *The Design of Children's Technology*, chapter 6: Children as Designers, Testers, and Evaluators of Educational Software, pages 123–145. Morgan Kaufmann Publishers Inc. 5, 63

Kail, R. (1988). Developmental functions for speeds of cognitive processes. *Journal of experimental child psychology*, 45(3):339–364. 52

Kail, R. (1991). Developmental change in speed of processing during childhood and adolescence. *Psychological bulletin*, 109. 52

Kail, R. (2000). Speed of information processing: Developmental change and links to intelligence. *Journal of School Psychology*, 38(1):51–61. 52

Kail, R. V. and Ferrer, E. (2007). Processing speed in childhood and adolescence: Longitudinal models for examining developmental change. *Child development*, 78(6):1760–1770. 52

Kelly, S. R., Mazzone, E., Horton, M., and Read, J. C. (2006). Bluebells: A design method for child-centred product development. In *Proceedings of the 4th Nordic conference on Human-computer interaction: changing roles*, pages 361–368. ACM. 61

Knox, G. (2012). 40 icebreakers for small groups. *Insight*. 15, 35, 86

Large, A., Bowler, L., Beheshti, J., and Nesset, V. (2007). Creating web portals with children as designers: Bonded design and the zone of proximal development. *McGill Journal of Education*, 42(1):61–82. 15, 62, 63, 87

Large, A., Nesset, V., Beheshti, J., and Bowler, L. (2006). "bonded design": A novel approach to intergenerational information technology design. *Library & Information Science Research*, 28(1):64–82. 62, 63, 74, 87

Lee, N. (2017). Lego boost teaches kids how to bring blocks to life with code. https://www.engadget.com/2017/01/04/lego-boost/. 58

LEGO BOOST (2016). Lego boost product text. Technical report, LEGO Group. https://lc-www-live-s.legocdn.com/r/www/r/boost/-/media/franchises/boost%202016/teaser/lego%20boost%20product%20text.docx?l.r2=-120530775. 2, 58, 59

Lego Boost Forum (2017). Lego boost images lego boost main hd wallpaper and background photos. http://legoboostforum.com/clubs/lego-boost/images/40280419/title/lego-boost-main-photo. 58

Lego.com (2017). https://www.lego.com/en-us/aboutus/news-room/2017/january/lego-boost. 2

Levine, Laura Ellen; Munsch, J. A. (2016). *Child Development From Infancy to Adolescence : An Active Learning Approach*. Los Angeles, Calif. : Sage. 50, 51, 52, 91

Lewis, A. (1992). Group child interviews as a research tool. *British Educational Research Journal*, 18(4):413–421. 8, 64, 66, 67, 72

Lewis, D. J., Saydak, S. J., Mierzwa, I. P., and Robinson, J. A. (1989). Gaming: A teaching strategy for adult learners. *The Journal of Continuing Education in Nursing*, 20(2):80–84. 57

Lopez-Mesa, B., Mulet, E., Vidal, R., and Thompson, G. (2009). Effects of additional stimuli on idea-finding in design teams. *Journal of Engineering Design*, 22(1):31–54. 120, 122

Lopez-Mesa, B. and Vidal, R. (2006). Novelty metrics in engineering design experiments. In *DS 36: Proceedings DESIGN 2006, the 9th International Design Conference, Dubrovnik, Croatia*. 120

MacLean, A., Young, R. M., Bellotti, V. M., and Moran, T. P. (1991). Questions, options, and criteria: Elements of design space analysis. *Human–computer interaction*, 6(3-4):201–250. 71

Malinverni, L., MoraGuiard, J., Padillo, V., Mairena, M., Hervás, A., and Pares, N. (2014). Participatory design strategies to enhance the creative contribution of children with special needs. In *Proceedings of the 2014 conference on Interaction design and children*, pages 85–94. ACM. 72, 73

Markopoulos, P. and Bekker, M. (2003). On the assessment of usability testing methods for children. *Interacting with computers*, 15(2):227–243. 1, 3, 51, 52, 71, 72, 73, 102, 114, 154

Mazzone, E., Iivari, N., Tikkanen, R., Read, J. C., and Beale, R. (2010). Considering context, content, management, and engagement in design activities with children. In *Proceedings of the 9th International Conference on Interaction Design and Children*, pages 108–117. ACM. 4

Mazzone, E., Read, J. C., and Beale, R. (2011). Towards a framework for co-design sessions with children. Conference Poster. 7, 57, 64, 67, 68, 77

Mazzone, E., Tikkanen, R., Read, J. C., Iivari, N., and Beale, R. (2012). Integrating children's contributions in the interaction design process. *International Journal of Arts and Technology*, 5(2-4):319–346. 9, 33, 55, 96, 114, 152

Miller, P. H. and Bigi, L. (1979). The development of children's understanding of attention. *Merrill-Palmer Quarterly of Behavior and Development*, 25(4):235–250. 51

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., and Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive psychology*, 41(1):49–100. 52

Moraveji, N., Li, J., Ding, J., O'Kelley, P., and Woolf, S. (2007). Comicboarding: using comics as proxies for participatory design with children. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 1371–1374. ACM. 23, 61, 104, 153

Moreau, C. P. and Dahl, D. W. (2005). Designing the solution: The impact of constraints on consumers' creativity. *Journal of Consumer Research*, 32(1):13–22. 150, 151

Nesset, V. and Large, A. (2004). Children in the information technology design process: A review of theories and their applications. *Library & Information Science Research*, 26(2):140–161. 1, 3, 49, 149

Onarheim, B. and Biskjaer, M. M. (2015). Balancing constraints and the sweet spot as coming topics for creativity research. *Creativity in design: Understanding, capturing, supporting*. 150, 151

Oosterholt, R., Kusano, M., and de Vries, G. (1996). Interaction design and human factors support in the development of a personal communicator for children. In *CHI*, volume 96, pages 450–457. 1, 104, 152

Print, M., Ørnstrøm, S., and Nielsen, H. S. (2002). Education for democratic processes in schools and classrooms. *European journal of education*, 37(2):193–210. 32

Read, J. C., Fitton, D., and Mazzone, E. (2010). Using obstructed theatre with child designers to convey requirements. In *CHI'10 Extended Abstracts on Human Factors in Computing Systems*, pages 4063–4068. ACM. 8, 35, 68, 69

Read, J. C., Gregory, P., MacFarlane, S., McManus, B., Gray, P., and Patel, R. (2002). An investigation of participatory design with children-informant, balanced and facilitated design. In *Interaction design and Children*, pages 53–64. Shaker Maastricht. 3, 4, 5, 7, 31, 49, 67, 72, 73, 79, 86, 96, 104, 111, 114, 149

Rindermann, H. and Neubauer, A. (2004). Processing speed, intelligence, creativity, and school performance: Testing of causal hypotheses using structural equation models. *Intelligence*, 32(6):573–589. 52

Ruffman, T., Perner, J., Olson, D. R., and Doherty, M. (1993). Reflecting on scientific thinking: Children's understanding of the hypothesis-evidence relation. *Child Development*, 64(6):1617–1636. 51

Ryan, R. M. and Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary educational psychology*, 25(1):54–67. 55, 73

Sanders, E. B.-N. (2005). Information, inspiration and co-creation. In *Proceedings of the 6th International Conference of the European Academy of Design*. University of the Arts Bremen. 1, 47

Sanders, E. B.-N. and Stappers, P. J. (2008). Co-creation and the new landscapes of design. *Co-design*, 4(1):5–18. 47

Sarkar, P. and Chakrabarti, A. (2011). Assessing design creativity. *Design Studies*, 32(4):348–383. 55

Scaife, M. and Rogers, Y. (1999). Kids as informants: Telling us what we didn't know or confirming what we knew already? *The design of children's technology*, pages 27–50. 3, 33, 71, 149

Scaife, M., Rogers, Y., Aldrich, F., and Davies, M. (1997). Designing for or designing with? informant design for interactive learning environments. In *Proceedings of the ACM SIGCHI Conference on Human factors in computing systems*, pages 343–350. ACM. 1, 3, 34, 67, 82, 149

Schuler, D. and Namioka, A. (1993). *Participatory design: Principles and practices*. Lawrence Erlbaum Associates, Inc., Publishers, Hills Dale, New Jersey. 48

Shah, J. J., Smith, S. M., and Vargas-Hernandez, N. (2003). Metrics for measuring ideation effectiveness. *Design studies*, 24(2):111–134. 9, 31, 117

Siegler, R. S. and Alibali, M. W. (2005). *Children's thinking*. Prentice-Hall, Inc, fourth edition edition. 50, 51

Slavin, R. E. (1987). Developmental and motivational perspectives on cooperative learning: A reconciliation. *Child development*, pages 1161–1167. 64, 65, 153

Sluis-Thiescheffer, R., Bekker, M. M., Eggen, J., Vermeeren, A. P., and de Ridder, H. (2011). Development and application of a framework for comparing early design methods for young children. *Interacting with Computers*, 23(1):70–84. 4, 15, 50, 60

Sluis-Thiescheffer, W., Bekker, T., Eggen, B., Vermeeren, A., and De Ridder, H. (2016). Measuring and comparing novelty for design solutions generated by young children through different design methods. *Design Studies*, 43:48–73. 1, 15, 60

Tabibi, Z. and Pfeffer, K. (2003). Choosing a safe place to cross the road: the relationship between attention and identification of safe and dangerous road-crossing sites. *Child: care, health and development*, 29(4):237–244. 51

Torrance, E. P. (1988). The nature of creativity as manifest in its testing. *The nature of creativity*, pages 43–75. 56

Vaajakallio, K., Lee, J.-J., and Mattelmäki, T. (2009). "it has to be a group work!" - co-design with children. In *Proceedings of the 8th International Conference on Interaction Design and Children*, pages 246–249. ACM. 56, 57, 61, 80, 93, 106, 108, 153

Vaajakallio, K., Mattelmäki, T., and Lee, J.-J. (2010). Co-design lessons with children. *interactions*, 17(4):26–29. 7, 67

Valkenburg, R. and Dorst, K. (1998). The reflective practice of design teams. *Design studies*, 19(3):249–271. 71

Van der Lugt, R. (2000). Developing a graphic tool for creative problem solving in design groups. *Design studies*, 21(5):505–522. 71

Van Mechelen, M., Gielen, M., Laenen, A., Zaman, B., et al. (2014). Exploring challenging group dynamics in participatory design with children. In *Proceedings of the 2014 conference on Interaction design and children*, pages 269–272. ACM. 66, 73

Van Mechelen, M., Zaman, B., Laenen, A., and Abeele, V. V. (2015). Challenging group dynamics in participatory design with children: Lessons from social interdependence theory. In *Proceedings of the 14th International Conference on Interaction Design and Children*, pages 219–228. ACM. 8, 15, 65, 66, 69, 87, 150

Vaughn, S., Schumm, J. S., and Sinagub, J. M. (1996). *Focus Group Interviews in Education and Psychology*. Sage. 1, 3

Vavoula, G. N. and Sharples, M. (2007). Future technology workshop: A collaborative method for the design of new learning technologies and activities. *International Journal of Computer-Supported Collaborative Learning*, 2(4):393–419. iii, 5, 6, 9, 11, 12, 33, 37, 63, 152

Vavoula, G. N., Sharples, M., Cross, J., and Baber, C. (2003). Spycam and robocam: An application of the future technology workshop method to the design of new technology for children. In *Proceedings of HCI International 2003*, pages 22–27. 5, 6

Vavoula, G. N., Sharples, M., and Rudman, P. D. (2002). Developing the 'future technology workshop' method. In *Proceedings of the International Workshop on Interaction Design and Children, Aug*, pages 28–29. 5, 6, 63

Vidal, R., Mulet, E., and Gómez-Senent, E. (2004). Effectiveness of the means of expression in creative problem-solving in design groups. *Journal of Engineering Design*, 15(3):285–298. 71

Vines, J., Clarke, R., Wright, P., McCarthy, J., and Olivier, P. (2013). Configuring participation: on how we involve people in design. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pages 429–438. ACM. 1

Vygotsky, L. (1978). Interaction between learning and development. *Readings on the development of children*, 23(3):34–41. 54

Wai, J., Cacchio, M., Putallaz, M., and Makel, M. C. (2010). Sex differences in the right tail of cognitive abilities: A 30 year examination. *Intelligence*, 38(4):412–423. 154

Walljasper, D. (1982). Games with goals. *Nurse Educator*, 7(1):15–18. 57, 103

White, G. B. and Davis, A. J. (1987). Teaching ethics using games. *Journal of Advanced*. 57

Williamson, B. (2004). The participation of children in the design of new technology: A discussion paper. *NESTA Futurelab, Bristol, UK*. 3

Wood, D., Bruner, J. S., and Ross, G. (1976). The role of tutoring in problem solving. *Journal of child psychology and psychiatry*, 17(2):89–100. 54, 68

Zastrow, C. and Navarre, R. (1977). The nominal group: A new tool for making social work education relevant. *Journal of Education for Social Work*, 13(1):112–118. 87

Ziemacka, A. (2017). Why teach kids programming? https://www.robocamp.eu/why-teach-kids-programming/. 58