

Designing with Young Children: Lessons Learned from a Co-creation of a Technology-Enhanced Playful Learning Environment

Nanna Borum^(✉), Eva Petersson Brooks, and Anthony Lewis Brooks

Department of Architecture, Design and Media Technology,
Aalborg University, Aalborg, Denmark
{nb, ep, tb}@create.aau.dk

Abstract. This paper reports on the lessons learned from working with creative visual methods with young children between the ages of 3 to 5 years-of-age in an early years educational setting in Southern Denmark as part of an 18-month project on Digital Playful Learning. The overarching goal of the study was to create a practice-based technology-enhanced playful learning environment. Collaboration was with the pedagogical education University College Syd-Danmark, the preschool teachers and the children. 55 children took part in the sessions. The study investigated a selection of methods developed for children, but not necessarily young children, such as the Bags of Stuff technique and the Mixing Ideas technique. This paper will discuss the advantages and challenges of these when applying them together with young children. The findings suggest that when working with younger children researchers should make efforts into understanding the children and their conceptual framework before engaging in design activities. In addition, young children need support in their creative expression.

Keywords: Early years education · Creative visual methods · Designing with young children

1 Introduction

With the rapid development of technology, traditional resources for children's play and learning have undergone major changes [1, 2, 3]. In Denmark 97 % of children of 3-5 years-of-age attend a preschool, and the municipalities, who govern 72 % of the preschools, are increasingly putting a focus on digitalising play and learning for young children [4]. In the context of this paper, all preschools in the present study have been equipped with an array of digital technology and playware as part of this effort.

Generally, the Danish children are quite familiar with technologies given that 99 % of families with children have a computer with Internet access at home, one third of the families have a tablet, and two thirds have a smartphone [4]. In addition, the parents of the children are generally positive towards children's access to technology with 94 % stating that technology should be a natural part of the every day lives of children [5].

The positive attitude towards technology is also reflected in numbers saying that families use different technological platforms more often compared to couples without children and people living alone [4].

In continuation of these numbers, this paper presents the lessons learned from a study where the overarching purpose was firstly to investigate how children in early years education in Denmark explore and play with digital technology and electronic playware. Secondly, the gathered information should feed into a practice-based design of a technology-enhanced playful learning environment created together with the children.

The study has been carried out following a Design-Based Research framework (DBR). DBR, originally coined by Brown [6] as design experiments, emphasises a merging of research, practice and design into one entity aimed towards extending current methodologies and theories in educational science [7, 8]. DBR underlines an iterative design process and allows for flexible and mixed methods [9].

In this paper we will draw on experience from the methods utilised in the field of interaction design, which bear commonalities with DBR when it comes to the design process [10]. In interaction design there is an emphasis on a user-centred design approach including methods such as design metaphors, interview with users, usability testing, video ethnography, use of focus groups, think aloud sessions and development of user personas (c.f. [11, 12]), all of which the results intend to inform the iterative design process. A challenge of these methods is that they are designed for adults and do not necessarily lend themselves to inquiries with young children [13]. The conceptual framework and terminology of children is inherently different than those of adults (cf. [14]).

Interaction design with children (IDC) and child-computer interaction (CCI) are emerging fields (cf. [12, 14, 15, 16]) where design researchers strive to meet some of the challenges of designing for and with children [13]. In their study, Read and Markopoulos highlight that current literature often neglects to consider the importance of the gatekeepers and the context and space of the inquiries that is unique to CCI. Moreover, researchers only seldom work with preschool children. This paper will try to meet some of these challenges.

2 Related Works

When including children in a design process Druin [14] differs between four roles the children can employ: *user*, *tester*, *informant*, and *design partner*. The main difference is the distribution of power between the children and the researchers. The first two terms, Druin [17] constitutes as reactive users. It includes methods such as video probes [18], children observing other children [14], play sessions [19], peer tutoring [20], co-discovery [21], and post-task interviews [22].

The last two terms, *informant* and *design partner*, Druin [17] categorises as participative users. The design process from this perspective includes techniques such as cooperative low-tech prototyping [17], drawings [15], technology immersion [14], and mixing ideas [23].

Iversen and Dindler [16] emphasise that participation is not necessarily equal to actual generation of knowledge but the term also covers “a means to end of exchanging and negotiating values among participants in a highly dialogic and iterative process facilitated by designers”. As advised by the preschool ([16] p. 26). In this sense children come to understand not only their own values, but also the values of their peers. Similarly Bødker, Ehn, Sjögren and Sundblad [24] pointed out that participation in itself could be considered as a way of learning.

3 Participants and Methods for Data Gathering

This project included children and their teachers as testers, informants, and design partners depending on the stage of the development process. In this paper we will however only cover the first stage of design process where the ideas were generated and hence the participants were:

- Preschool Teachers: 9 (7 female, 2 male) who came from five different preschools across Southern Jutland, Denmark. The teachers volunteered to participate.
- Students from preschool teacher education: 25, (13 female and 12 male) who came from the pedagogical educations at University College SydDanmark across Southern Jutland, Denmark. The students functioned as facilitators of the sessions with the children.
- Children: 55 boys and girls between 3-5 years-of-age came from five different preschools in Southern Jutland, Denmark. The children were selected to participate by the preschool teachers on the criteria that the children should neither be shy or over active.

3.1 Procedure

The study has utilised a number of creative participatory methods to inform the design of the technology-enhanced playful learning environment. In the context of this paper, the product of the process, i.e. the virtual environment, will not be treated, but merely the lessons learned from the methods utilised to create the environment.

3.2 Data Gathering

All sessions except the Ice Breaking sessions were video recorded, photographed and the creative contributions were archived for later analysis.

4 Setting the Scene

When working with young children there are a lot of considerations to take into account. First of all, ethical considerations, which will however not be covered in this paper (see [2, 25] on the ethical directions this project has followed). Secondly,

preparations have to be put into how to get to know the children and hence be able to design together with them. An emphasis was on enabling the researchers' understanding of the children's conceptual frameworks. Even though efforts were put into ensuring this coherency, when working with children surprises always happen. As noted by Veale [15], working with younger children calls for equal amounts of preparation and flexibility.

4.1 Breaking the Ice

Background. Before engaging in the actual design process with the children, this project worked with a set of techniques in order to ensure an equal distribution of power between the researchers and the children. Fails, Druin, Bederson, Weeks and Rose [26] describe that a means to equalise the power is by only using first names, wearing informal clothes, sitting on the floor, and not using a raise of hand when speaking. In Denmark, the three former would be how teaching naturally is conducted in preschools, so instead the efforts were put into ensuring good communications between children and adults. Different methods for getting-to-know-each other are common when bringing groups together for e.g. teamwork and creative work especially in the fields of team building and Human Resources (cf. [27]).

How It Was Used. As advised by the preschool teachers, the first day in the different preschools had sessions that were dedicated to breaking the ice. The sessions were aimed towards building trust and friendship between the preschool teacher students, who functioned as facilitators of all the sessions, and the children. In order to do so, the preschool teacher students did two things; (a) they played and sang with the children and (b) the children took the preschools teacher students out on a tour in the preschool to present their favourite spots. The children were handed a set of stickers that allowed them to categorise the different spots in e.g. "best place to play wild" and "best spot to fantasise" in order to trigger the conversation.

Lessons Learned. The activities were intended for the children to build ownership of the process. The experience was that neither of the methods should stand alone. The playing and singing were beneficial for building a relationship between the children and the preschools teacher students. The children quickly seemed to feel comfortable with the new adults present in the preschool. The sticker tour proved efficient in two ways; (a) it gave the children initiative and a "voice" and hence sparked communication, and (b) it helped clarifying to the children that the preschool teacher students did not have the same role as the children could expect from their regular teachers. The children understood that there was a task at hand that they could help solving, which in return again supported a sense of ownership and empowerment through the process. The experience was supported by feedback from the parents of the children, who expressed that the children were very proud of their participation and that they talked a lot about the process at home.

As a means to not be invasive in the icebreaking process, these sessions were not video recorded and data from the sessions consisted only of verbal feedback from the preschool teacher students, the preschools teachers, the verbal feedback from the parents, and field notes.

4.2 Establishing a Common Ground

Background. “All collective actions are built on common ground and its accumulations.” ([28], p. 127). From the basics of communication theory it is evident that when two people communicate the process it contains more than just planning when to speak and listen. It is merely an on-going process where both parties constantly update their models of what the counterpart know and together they create a shared base to converse from. When working with children Clark [29] found that infants down to age of 14 months are able to establish a common ground with adults and are able to build on the shared knowledge in the further communication.

How It Was Used. The researchers spent time watching children’s television, reading children’s books, learning children’s songs and scouted out what was trending in the toy and app industry. This was done in order to ease the establishment of a common ground when talking with the children and also to aid the analysis and understanding of children talking with children.

Lessons Learned. The experience was that when the children realised that the researchers were aware of their universe they more easily opened up and discussed. In the sessions where the children played freely with technology, it was key to understand their frameworks in order to understand their play. The children’s play was often bound in the physical world meaning that it was initiated from the objects at hand, but the play frame the children engaged in was not spontaneous, but merely initiated from existing frames of the children. The children would evolve their stories around existing characters from children’s literature and television (cf. [30]). In one example, a group of children were playing in a Kinect-based system developed for the project where the children were able to draw interactive objects on the wall. The children stated that their creation was a character from a Danish children’s novel. In the book a boy is able to draw with crayon on the wall and everything he draws comes to life. The association between the system and the book was not far reached and if the researcher had failed to recognise the child’s association we would also have failed to recognise that the young child actually had a good understanding of the system features.

4.3 Framing the Sessions

Background. As emphasised by Veale [15] and Markopoulos et al. [2] when working with children and perhaps even more when working with young children, planning and preparations are crucial to create a good experience for the children and also to strengthen the results of the design process. Not only following the ethical guidelines for working with children, which state that children should not be put in distress by being put into unfamiliar settings (cf. [2]), the use of field studies and in situ interviews also gives richer data, in comparison to a controlled lab setting, when the scope is to understand how young children use technology in their everyday lives.

How It Was Used. Since the sessions were carried out in five different preschools, naturally the type of rooms and décor differed from place to place. The aim was that the use of the room should feel natural to the children but also not cause any organisational problems for the preschool. In some of the preschools the preschool teachers intentionally selected the rooms for the purpose (a play room for an active session, a creative

workshop for a creative session, and so on) and in others the rooms were selected out of convenience by the preschool leaders. In all sessions the researchers, the preschool teacher students and the children made flexible use of the objects available in the room such as a mattress on the floor, a stereo system to play music, and costumes to act out. **Lessons Learned.** A tendency was clear from the different settings; the children would carry with them the perceived and interpreted affordance of the space into the design activities. This meant that when the activities were carried out in a room regularly used as a creative workshop, the children sat down and focused mainly at the task at hand in contrast to when the creative activities were carried out in a room utilised for physical play. Here the children would be more physically active, use the whole space, bring in other objects for their creations and have more difficulty in staying focused.

Another experience from the field studies was that, in the instances where the preschool teacher students wanted to interview the children about their opinions on different technologies and digital playware, it was of benefit to physically frame the setting. In one session the frame was a big mattress on the floor, in another it was lines one the floor surrounding the children and preschool teacher students. It signalled to the children that this is where the action takes place and the sessions where this was applicable were more successful in regards to letting the student preschools teachers connect with the children.

5 Creative Design Methods

In this section we present two different visual creative methods for designing with children that were utilised in the project. These were used in the initial phase of the project and hence helped inform the requirements and design guidelines for the concept development.

5.1 Drawings

Background. The use of children's drawings as a means for investigating children's experiences is not of new date. As cited in Veale [15] the use can be dated back to early 1900 s in psychology as a tool for assessment of cognitive and emotional functioning. Veale has experimented with using drawings as a method for understanding children's experience in different ways, e.g. free drawings, commenting on generic drawings, and interpreting other children's drawings. Not all methods were equally successful in obtaining the interest of the children. The author stressed that even though drawings contain visual data, it was the children's interpretations of the drawings that yielded more rich data for interpretation.

Developed from the Cooperative Inquiry approach, another drawing technique that inspired the work in this project was the Mixing Ideas technique [31, 32]. The technique was developed for design work with younger children and hence takes into account the extra support needed for interpreting the drawings together with the children. The work is centred on the metaphor of baking cookies meaning that the ideas of the children become "tastier" and richer when mixed together.

How It Was Used. In the Mixing Ideas technique the children's ideas are mixed together using scissors and glue, which enabled the children to, by guidance of adults, stick together ideas as they see them fit. In the context of this project, the children worked with drawings in two different ways. In one preschool the children, in groups of 4-6 children, collaboratively worked to create universes and stories together using a large piece of paper that was rolled across the floor (see Fig. 1). Adults annotated the drawings in order to keep track of the story that emerged from the drawings. In other preschools the children worked in pairs together with a preschool teacher student to produce drawings on postcards that then afterwards could be mixed, matched and rearranged to form the stories of the children's likings.



Fig. 1. Children and adults drawing together

Lessons Learned. Originally the Mixing Ideas technique was grounded from Cooperative Inquiry based on the experience that younger children need more assistance in combining the ideas of each other [32]. In the sessions where children were drawing together in groups of 4-6 people this was a challenge. The researchers experienced that, in spite of trying to accommodate the knowledge from Guha et al. [31] by assisting the children, it still proved difficult to let ideas spark from each other without having some children feeling left behind. The group was too big for the children to be able to still see their ideas in play. This was only a minor problem in the groups where two children drew together.

Another challenge, which was evident in both types of drawing sessions, was that when the young children were asked to make up a story and draw it, it was too abstract for them. The intention with the task was to see what types of story world they would create and to let this knowledge inform the design of the interactive environment. The children would either draw stories related to e.g. famous fairy tales or their favourite TV-shows. In one session one preschool teacher tried to spark the imagination of children by introducing different play figurines such as dragon or a knight, which

helped bring depth into the children's stories and make them develop more to the story line. Unfortunately it also streamlined the stories so that the general concept of the stories was basically the same.

5.2 The Magical Suitcase

Background. The Magical Suitcase as it was called in this project, draws heavily on the brainstorming technique from Cooperative Inquiry [17] often referred to as the Bags of Stuff technique. Originally adapted from Bjerknes, Ehn and Kyng [33] the technique aims towards creating lo-fi prototypes in teams; children and adults together. The goal is to get as many solutions as possible. The groups are provided with several types of art supplies and presented to a problem that needs solving. Typically the technique has been used with children between 7 to 11 years of age.

How It Was Used. Given that the participants who took part in this project were younger children, the use of the Bags of Stuff technique was accommodated accordingly. The Magical Suitcase was a suitcase filled with not only art supplies but also different objects with assigned meaning (see Fig. 2), e.g. a couple of glasses were told to be magical which would allow the children to see everything they wanted to see. The intention was that instead of focusing on building actual lo-fi prototypes, instead the materials provided should open up for different types of play than the children would not usually engage in. In addition, the hope was that the material would open discussions between the children and preschool teacher students on the possibilities and limitations with technology. Each group consisted of 5-6 children and 2-3 preschool teacher students that together engaged with the different materials.



Fig. 2. The magical suitcase with a selection of the content

Lessons Learned. A challenge was that the stories built around the different objects did not have enough depth to engage the children. It was wrongfully anticipated that when young children were told that e.g. a potion or a set of glasses were magical, it would spur enough interest for them to start exploring and playing with the objects. Instead they most often wanted the background story on how these object became magical and similar questions before being intrigued into the play.

6 Conclusion

The overarching goal of the study presented in this paper was to investigate how young children make use of digital technology in their everyday lives in a preschool setting and to let these experiences inform the design of a technology-enhanced playful learning environment. The information was provided through a set of field studies, which was derived into design requirements and design guidelines in an iterative design process. The children were included in the design through a number of creative methods for designing with children adapted from Cooperative Inquiry [17]. Moreover, efforts were put into setting the scene for the following design sessions.

The work focused around adapting design methods designed for children, but not necessarily young children, and applying these on a target group of children between 3-5 years-of-age. The findings suggest that when working with young children preparations have to be carefully considered in order to engage the children in the design process. Creating a common ground was essential to communication. Techniques for breaking the ice were beneficial for building trust between the children and the facilitators of the sessions. In addition, setting the right physical frame for the sessions improved the quality of the design solutions.

The creative methods utilised for the cooperative design process was transferred to the younger target group with difficulty. Adding objects that intentionally should open up for playful creations of new play scenarios modified the Bags of Stuff technique [26]. The results indicate that such a modification of the technique can potentially add value to the design process, however more work has to be put into the stories behind the objects in order to engage the children.

Some sessions included drawing techniques inspired from the Mixing Ideas technique [31], which also presented itself with challenges. The children's ability to communicate through drawings differs and hence the sense of skill and ability change the motivation the children have towards the task. Moreover, the children find it hard to draw something from free imagination and the help of adults can easily affect the direction of the children's drawings.

The findings imply that further development of design methods for young children are needed.

Acknowledgements. University College SydDanmark supported the study presented in this paper.

References

1. Buckingham, D.: *After the Death of Childhood: Growing Up in the Age of Electronic Media*. Polity Press, Oxford (2000)
2. Markopoulos, P., Read, J.C., MacFarlane, S., Höysniemi, J.: *Evaluating Children's Interactive Products: Principles and Practices for Interaction Designers*. Morgan Kaufmann Publishers, Burlington (2008)
3. Rogers, Y., Price, S.: How mobile technologies are changing the way children learn. In: Druin, A. (ed.) *Mobile Technology for Children: Designing for Interaction and Learning*. Morgan Kaufmann Publishers, Burlington (2009)
4. Rambøll Management Consulting & Implement Consulting Group.: *IT og digitale medier er kommet for at blive: Kortlægning af digitale redskaber på dagtilbudsområdet*. Rambøll, Copenhagen (2014)
5. Analyse, K.M.D.: *Den digitale daginstitution: En temperaturmåling af daginstitutionernes digitale tilstand og potentiale*. KMD, Copenhagen (2013)
6. Brown, A.L.: Design experiments: theoretical and methodological challenges in creating complex interventions in classroom settings. *J. Learn. Sci.* **2**(2), 141–178 (1992)
7. Barab, S., Squire, K.: Design-based research: putting a stake in the ground. *J. Learn. Sci.* **13**(1), 1–14 (2004)
8. Wang, F., Hannafin, M.J.: Design-based research and technology-enhanced learning environments. *Educ. Tech. Res. Dev.* **53**(4), 5–23 (2005)
9. Andersson, T., Shattuck, J.: Design-based research: a decade of progress in education research? *Educ. Res.* **41**(1), 16–25 (2012)
10. Zimmerman, J., Forlizzi, J., Evenson, S.: Research through design as a method for interaction design research in HCI. In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pp. 493–502 (2007)
11. Sharp, H., Rogers, Y., Preece, J.: *Interaction Design: Beyond Human-Computer Interaction*, 2nd edn. Wiley, New York (2007)
12. Antle, A.N.: Child-based personas: need, ability and experience. *Cogn. Technol. Work* **10**(2), 155–166 (2008)
13. Read, J.C., Markopoulos, P.: Child-computer interaction. *Int. J. Child-Computer Interaction* **1**(1), 2–6 (2013)
14. Druin, A.: The role of children in the design of new technology. *Behav. Inf. Technol.* **21**(1), 1–25 (2002)
15. Veale, A.: Creative methodologies in participatory research with children. In: Greene, S., Hogan, D. (eds.) *Researching Children's Experience: Approaches and Methods*, pp. 253–272. Sage, London (2005)
16. Iversen, O.S., Dindler, C.: A utopian agenda in child-computer interaction. *Int. J. Child-Comput. Interact.* **1**(1), 24–29 (2013)
17. Druin, A.: Cooperative inquiry: developing new technologies for children with children. In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems: The CHI is the Limit*, pp. 592–599 (1999)
18. Hutchinson, H., Mackay, W., Westerlund, B., Bederson, B.B., Druin, A., Plaisant, C., et al.: Technology probes: inspiring design for and with families. In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pp. 17–24 (2003)
19. Marco, J., Cerezo, E., Baldassarri, S., Mazzone, E., Read, J.C.: Bringing tabletop technologies to kindergarten children. In: *Proceedings of the 23rd British HCI Group Annual Conference on People and Computers: Celebrating People and Technology*, pp. 103–111 (2009)

20. Labrune, J.B., Mackay, W.: Tangicam: exploring observation tools for children. In: Proceedings of the 2005 Conference on Interaction Design and Children, pp. 95–102 (2005)
21. Bruckman, A., Brandlow, A.: HCI for Kids. In: Jacko, J., Sears, A. (eds.) *Human Computer Interaction Handbook*. Lawrence Erlbaum, Hillsdale (2003)
22. Baauw, E., Markopoulous, P.: A comparison of think-aloud and post-task interview for usability testing with children. In: Proceedings of the 2004 Conference on Interaction Design and Children: Building a Community, pp. 115–116 (2004)
23. Guha, M.L., Druin, A., Chipman, G., Fails, J.A., Simms, S., Farber, A.: Working with young children as technology design partners. *Commun. ACM* **48**(1), 39–42 (2005)
24. Bødker, S., Ehn, P., Sjögren, D., Sundblad, Y.: Co-operative design: perspectives on 20 years with “the Scandinavian IT Design Model”. In: Proceedings of NordiCHI 2000, pp. 1–9 (2000)
25. Pink, S.: *Doing Visual Ethnography*, 2nd edn. Sage, Thousand Oaks (2007)
26. Fails, J.A., Druin, A., Bederson, B.B., Weeks, A., Rose, A.: A child’s mobile digital library: collaboration, community, and change. In: Druin, A. (ed.) *Mobile Technology for Children: Designing for Interaction and Learning*. Morgan Kaufmann Publishers, Burlington (2009)
27. Midura, D.W., Glover, D.R.: *Essentials of team building: principles and practices*. Human Kinetics, Champaign (2005)
28. Clark, H.H., Brennan, S.E.: Grounding in communication. *Perspect. Socially Shared Cogn.* **13**, 127–149 (1991)
29. Clark, H.H.: *Using language*. Cambridge University Press, Cambridge (1996)
30. Johansen, L.S.: Medier i hele kroppen: Når små børn bruger medier. *Barn* **1**, 63–78 (2010)
31. Guha, M.L., Druin, A., Chipman, G., Fails, J.A., Simms, S., Farber, A.: Mixing ideas: a new technique for working with children as design partners. In: Proceedings of Interaction Design and Children 2004: Building a Community, pp. 35–42 (2004)
32. Fails, J.A., Guha, M.L., Druin, A.: Methods and techniques for involving children in the design of new technology for children. *Found. Trends @ Hum.-Comput. Inter.* **6**(2), 85–166 (2012)
33. Bjercknes, G., Ehn, P., Kyng, M.: *Computers and Democracy: A Scandinavian Challenge*. Alebury, Aldersho (1987)