ISSN 2278-3091
Volume 8, No.1.4, 2019
International Journal of Advanced Trends in Computer Science and Engineering
Available Online at http://www.warse.org/IJATCSE/static/pdf/file/ijatcse7581.42019.pdf
https://doi.org/10.30534/ijatcse/2019/7581.42019

# Children Involvement in Participatory Design Process: A Background Review

**Mohammed Alhatem[1], Azrina Binti Kamaruddin[2], Norhayati Mohd Ali[3], Abdul Azim Abd Ghani[4]**
Faculty of Computer Science and Information Technology
University Putra Malaysia (UPM), Malaysia,
[1]Mhalhatem@imamu.edu.sa
{[2]Azrina, [3]Hayati, [4]Azim}@upm.edu.my

**ABSTRACT**

Child-Computer Interaction (CCI) research has discovered that there are numerous benefits of involving children in the process of designing new technology. Specifically, children with disabilities have become a potential target of CCI researchers focusing on participation with children in the process of technology design, applying design methods such as participatory design (PD). We aimed to highlight the lack of research that investigates the insight of children with VIs in the technology design process. In addition to the roles that children can play during the design activity. Methods, we identified the PD processes of when children with VIs have been participated in design activity from existing research and conducted a literature review of empirical studies of co-designing with VIs children. The main result shows that children with VIs can play the role of a design partner during the design process. The current state of evidence supports that the PD can have a positive impact on involving children with VIs in the design process.

**Key words :** Participatory design, co-design, design process, children with vision impairment.

## 1. INTRODUCTION

World Health Organization (WHO), reported that there are more than 1.3 billion people worldwide have some degree of VIs. Among them, 217 million have moderate to severe VI, and 36 million (14%) are blind, [1]. Also, the WHO estimated that the number of people with VIs and blindness would grow to 200 million and 75 million respectively by the year 2020. Individuals with VIs face many challenges regarding orientation and mobility, which impact their health as well as personal, professional, educational, social lives, and well-being. Children with VIs are among those individuals who are facing challenges.

Children lives with VIs have increasingly become users of a different set of technology such; assistive technology educational technology, and entertainment technology. However, a debate being about how those technologies should be designed for this group of users. Current research identified some issues and challenges that children with VIs are facing part of the technical support such as participation [2], collaborative learning [3] social engagement [4] isolation [5].
However, technologies that designed to be useable by children with VIs have designed by typical normal adults who may do not understand children with VIs.

CCI is a subset of Human-Computer Interaction (HCI) but focused on children. However, research in the field of CCI has been established. Researchers have recognized the significant of directly involving children in the technology design process. Their research has directed to the development of numerous methods of design for involving children in the technology design process. Nowadays, researchers are looking into involving children with different needs and disabilities, children with VIs one of such groups where there is rising attention in discovering ways to include them in design processes across numerous domains such; home spaces [6], audio-tactile mock-ups [7], audio-haptic interfaces [8], since the technology could be significantly helpful for enhancing the quality of life of children with VIs.

PD establishes a vision and an approach for involving a group of users who affected by technologies into the design process. The PD has a range of features that motivate its adoption, such as addressing a pragmatic need, fitting between features and users' requirements, empower people, designing alternative futures and democratize innovation [9]. The PD is particularly powerful when designing technology for groups of users who are far from the eyes of designers and researchers and groups who are marginalized in the design such as people live with different kinds of disabilities or have life-worlds.

The PD literature, there are different techniques and methods of how to engage participants during the design process. However, methodological choices, rationales, the strategies of translating methods into actual activities have not mentioned clearly, which could affect the designer's ability to build effective teamwork with different groups of users. Lately, researchers are actively seeking to engage children with different kind of disabilities into the PD processes. However, little research has sought to co-design technology with VIs children, and hardly ever reported about methods and techniques on how to engage children with VIs during the PD process. This gap is essential mainly as there are needs to re-interpretation and adaptation the existing methods based on understanding the user's needs and abilities to come out

with ways and methods for facilitating the engagement during the design process.

This paper aims to offer a background review on studies that used PD in the context of engagement of children with VIs.

## 2. BACKGROUND

In this section, we will address some definition and contexts of the UCD and the PD and the relations between them.

### 2.1 User-Cantered Design

ISO 13407: 1999 states that the goal of UCD is to "ensure that the development and use of interactive systems take account of the needs of the user as well as the needs of the developer and owner...to name but a few stakeholders" (ISO 9241-210: 2010). Similarly, ISO 9241-210: 2010 explains the primary rationale for UCD as a process that can deliver easier to understand and usable products.

The process of UCD has many variations based on the need. Where designers are looking to select among the many different methods and techniques based on their need for requirements to discover or solution to test, the designer can also adopt the same method for various design situations[10], [11]. Within the UCD process, designers often ask users about what they need, want, and desire. However, answering these questions can be difficult for users since they may not have experience in products or services. Therefore, the participation of users is mostly in the specification phase, gathering of requirements and in usability testing, whereas designers and professionals have mainly carried out the rest of the design process phases.

### 2.2 Participatory Design

The PD and is a subset of user-cantered design (UCD). PD was developed out of the Scandinavian approach that is a collaboration between trade unions and the industry in the 60s and 70s [12]. According to Computer Professionals for Social Responsibility (CPSR), PD "is an approach to the assessment, design, and development of technological and organizational systems that places a premium on the active involvement of workplace practitioners usually potential or current users of the system in design and decision-making processes". PD is a design approach that offers methods and techniques which can be employed by groups of designers and users working together through the design process that includes brainstorming, programming, building, and testing [13]. The main idea of PD is designing with users rather than designing for users [14]. Users within the design process using PD are not only a source of information, but they are full participants and contributors to the design of the products and services.

According to [12], users' involvement in PD is reaching a deeper level of understanding via active participation of users in the process of design where users can also be a component of the design team. Moreover, PD can be a new approach to design that requires new ways of thinking and working [15]. PD can also be defined as a set of theories and practices that highlight end-user participants' role in the process of design. Nowadays, the term co-design is being used increasingly instead of PD. However, PD is still considered as a step forward from UCD. In [16] outline the connection between co-design (CoD) and co-creation as the following: "Co-design is a process, and the planning, adjusting tools, and facilitation is built on a mindset based on collaboration, co-creation can take place within co-design processes but focuses much more on the collective creativity of involved users and stakeholders". Therefore, there is no single way for co-designing with users, but there are many methods and activities that can be used in all stages of the PD lifecycle. The PD often conducted by workshops include activities such as desiccation, generating ideas, and building prototypes [17].

HCI researchers discovered the potential of PD in its research and practice. Hence, PD has become the third part of HCI [18]. Meanwhile, it is uniting a diverse range of knowledge into new plans and visions for action, which includes, creating new ideas, learning reciprocally, working languages, understandings, relationships and, discussions across differences. Regarding, CCI research [19] highlighted two ways of involving children during the PD process where children could contribute to the technology design process, (1) to build fit technology, (2) for the empowerment of children involvement. Thus, the consequences of the design process which could contain different stages of effect on both the child participants themselves and resulting technology, based on children involvement level and their contributions during the design process. These contributions usually achieved via the result of engagement at PD stretched workshop of small design teams over a while developing design ideas [20] or through involving big numbers of children a short time workshop to gather ideas to guide designers [21].

## 3. CHILDREN'S INVOLVEMENT IN THE DESIGN PROCESS

Designing with children is challenging based on their ability to communicate and express themselves, which affects their contribution and interaction with the world around them. However, finding ways to include children experiences is important in order to explore the way they solve problems and make decisions related to their need and their way of life. According to [22], involving users in design and decision-making processes is difficult due to existing power gaps, biases, pre-made assumptions, particularly for children who face problems expressing feeling and thought. Landoni et al.,[23] stated that over the last decade, children had been involved in the technology design process.

However, there are still concerns about their engagement in all phases of the design process, since they are considered as

users of the product or service in many cases. Nowadays, there are a number of PD methods that target children in improving their ability to communicate and adapting to their individual needs. These design methods help designers to participate with children in the design process more efficiently.

**3.1 The role of the children**

From the existing literature, there are many different ways where children can be included in the design process. In [22] has come up with a model that describes the diversity of roles where children can take part in the design process, namely child as a user, child a tester, child an informant, and child a design partner. Children, as users are the first role discussed in the literature. Researchers observe videotape or test children using technology to understand how they interact with it and how it affects them [24]. The child in the role of a tester is involved in the design process by testing prototypes of developing technologies. The child as informant can be done by using observation methods or asking questions such as "what do you like." Child as a design partner, where children are involved in all design stages from the beginning until the end as an equal stakeholder during the process of designing new technology [25]. Observing the design partner and informant is similar; the main difference between them is that the informant child role has some limitations in the design process.

Children as co-researchers are a role that children can play through participation in the design process. Children in this role are enabled to gather, share, and analyses data as participants [26]. In addition, [27] have extended Druin's model by adding the role of the protagonist, where children are empowered to shape the design process. In this role, children are treated as protagonists and encouraged to drive the design process, working together to produce something, enhancing their skills of design, and reflective thinking.

**Table 1:** The roles which children can play in the design process

| Child as | Purpose | Methods | Outcome |
|---|---|---|---|
| User [22] | Investigating or testing an overall impression which can assist in informing future technology. Providing a good understanding of the needed process and how to improve future practices. | Observation, videotaping, testing before and after the use of technology. | Knowledge about technology use and learning experience. |
| Tester [22] | To understand the way of the usage of a particular technology by children and improving the technology based on that understanding . | Prototype testing of a specific technology. | Knowledge about the potentials of experimental, usability, and utility. |
| Informant [22] | To gain information at specific steps of the process of design to inform the design, this can be done by covering the experience and knowledge of the children. | Observation during the use of technology and asking questions during the design process. | Knowledge about children's experience with the designed technology. |
| Design partner [22] | To gain the voice of children in the design process where adult designers and children co-design a new technology by means of a partnership. | Engage with the design team in all design workshops as equal to adult designers. | Knowledge about the contribution of children in the design and development of technologies . |
| Co-researcher [26] | To gain a contextual knowledge of adult designers and children by involving children in studying children's performance. | Contributing to the design process by gathering, sharing, and analyzing the data. | Knowledge about the design itself, including environment, gathering data, sharing data, analyzing data, and implementing knowledge in new technology design. |
| Protagonist [27] | To gain an understanding of children being the central element of the | Being the central component of the design, completing | Knowledge about children's visions in the designing of |

| | | | |
|---|---|---|---|
| | design process by leading the design process, via developing design skills that effect in the role of the technology in their lives. | the whole design process, and reflecting that in the product. | technology as well as their attitudes about technology in their own lives. |

Furthermore, some models have tried to define the different forms of involvement. In [28] proposed a distinguished model that is formulated as a ladder. This model points out that there are three types of non-participation to be added to real participation, where children can participate in the design process, but their participation is not significant. This participation ladder, as illustrated in Figure 1, has been significant in the field of children involved in the design process even though there is a criticism of it among designers. This ladder is a hierarchy where the mean goal of involvement in the design process is to get to the top stage where children could share design decisions with adults. It highlights that the nature of the products or services, children's abilities, characteristics, and additional needs are the most appropriate form of involvement during the design process. Therefore, considering children with different kinds of disability is essential.

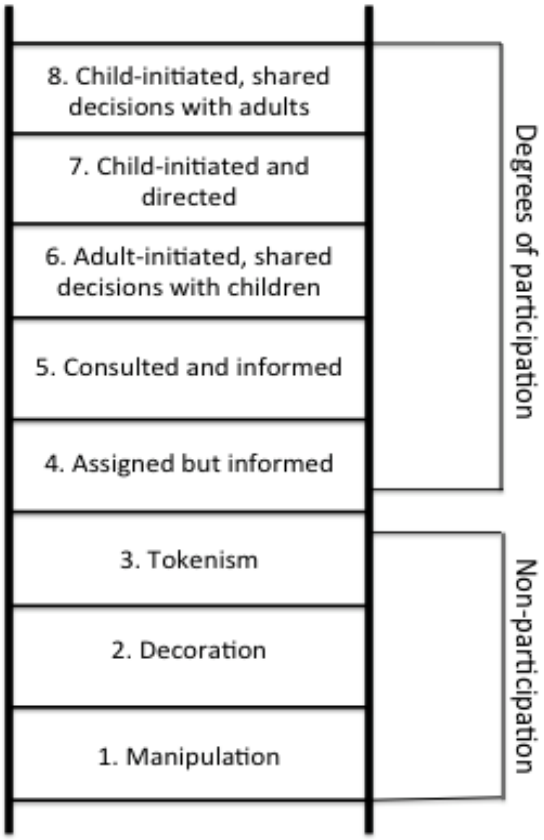


**Figure 1:** Ladder of Participation [28].

In [29] have come up with a design method called "Bonded Design." It emphasizes on the level of participation between children and adult designers that can be encompassed within the role of the Informant and Design Partner. Large et al. believed that children could involve as design partners throughout the process, but at the same time, they do not believe that children can be equal to adult participation in the design process.

In [30] presented three modes for including children in the process of technology design. Starting with (1) informant design, where the decisions made by designers to comprehend the design, and at the same time, given children a chance to inform the designers, (2) balanced design, where children and adult designers have a strong relationship, and sharing the responsibility during the design process by given children an equal voice as same as designers, and (3) the facilitated design. In this mode, the adult designers are facilitating the design process, and expecting children to lead the design by beginning ideas and making decisions during the design process.

In [31] has involved children in design technology as software designers. Children were asked to build and design a game for other children individually and within groups. In this model, children lead the game implementation, where adults provide technical help to the children. That said, products that have been created based on this process do not typically target wider distribution among users. Additionally, the products intended for specific users might differ from products that have been designed for use by a wider population.

In [32] used both Druin's levels of involvement and Hart's ladder of participation as inspiration for his Design Participation Ladder. The ladder considers the involvement of children who lives in the undeveloped world specifically. The ladder three stages of involvement; (1) where adult designers observe the children activities and answering the basic questions they may ask; (2) consultation, where children involvement is not required in the design process, but children can be asked to generate their requirements and favorites; and (3) empowered, children here can learn skills and fully participate in developing solutions.

### 3.2 Balance of Power

The balance of power is a crucial issue in building a culture for engaging children in the design process. Within each of the roles of participation, there are different distributions of power between adult designers and children. In [33] reported that there is a need for power balance between children and adults, but the power balance cannot be distributed equally among them in all situations. Regarding the possibility of achieving a truly equal partnership between adults and children, many researchers are reservations such as [34] and [35] argued that empower children during design process is

not about giving children equal responsibilities as same as adults, but there is a need for developing the confidence among children and adult to allow them to share opinions and ideas with the design team members.

However, adult and child interaction during the design process is often defined in terms of the sharing of power or balance of power [36]. These forms can range from children who are just aware of the design project and have no authority in making the decision to having some power or sharing the power with designers to leading the design process and making the final decision. Table 2 shows the forms of involvement children can undertake in each role.

**Table 2:** The relationship between the balance of power and the existing methods/forms/levels of involving children in the process of designing technology

| **Forms/ levels of Involvement** | **Role of children involvement within the process of designing technology** | | | |
|---|---|---|---|---|
| | **Children lead designers** | **Children and designers share** | **Children have power, but designers lead** | **Children have no power** |
| Kafai [31] | Children as designers and adults as facilitators | - | - | - |
| Druin [37] | - | Design partners | Informant | Users Testers |
| Read [30] | Facilitated design | Balanced design | Informant design | - |
| Large [29] | - | Bonded design (Task leve) | Bonded design (Project level) | - |
| Hussain [32] | - | Empowered | Consulted | Included |
| Frauenberger [38] | - | - | Full participation | Participation via proxy. Non-participatory |
| Van Doorn [26] | - | Co-researcher | - | - |
| Iversen [27] | - | Protagonist | - | - |

## 4. INVOLVEMENT OF CHILDREN WITH VISION IMPAIRMENT

A number of researchers have studied the participation of children with disabilities. In [38] proposed a ladder to involve children with different kinds of disabilities in the design process. They proposed three levels of participation including (1) Non-participatory, where the best practices, theories, and experiences, used to guide the design process; (2) Participation via proxy, where somebody can participate on behalf of the child in the design process. That person can be a parent, teacher, or care provider, and (3) Full participation, where children have a full impact on the design process. Furthermore, a number of researchers have also studied the participation of children with different kinds of disability based on Druin's model as the table below shows (See Table 2).

**Table 3:** Role of children with disabilities in the technology design process

| **Disability** | **Level of Involvement** | **Ref** |
|---|---|---|
| Blind/ vision impaired | Design Partner | [39] |
| Behavioral difficulties | Design Partner | [40] |
| Physical/Learning Disabilities | Informant | [41] |
| Deaf | Informant | [42] |
| Autistic Spectrum | Tester and Design Partner | [43] |
| Hearing impaired | Informant | [44] |
| Specific Learning Difficulty | Informant | [45] |

Regarding children with VIs, there is a lack of research that investigates the role which they should play during the design process. However, [46] investigated the use of game design as a means of engaging young people with vision therapy. Also, they address some issues of designing vision-based games for people with VI using PD. The work uncovers some challenging needs to be fulfilled, such as ensuring that accessibility guidelines are considered, and players are not unnecessarily frustrated. One of the drawbacks of using a PD approach is the critical potential, as a process of discovering and testing activities that participants find challenging when design and use a product for exposing the participant vulnerabilities. There is a lack of a long-term user study to obtain a deep understanding of the users and their experience, and engagement was the main limitation of the study. In [14] co-designed with adults who were visually impaired, but the focus was to provide a means for participation, rather than methods of involvement.

## 5. METHODOLOGY

The process of Identifying reviewed research papers and articles of the relevant literature. We conducted the search in March 2019; the coverage period was literature published between 2004 - 2019. First, we selected the databases that are going to be searched. The following databases were selected: ACM Digital Library, Science Direct, Google Scholar, Scopus, Web of Science, and the Conference of Participatory Design. Second, we identified the terms and keywords was used to retrieve relevant literature, a Boolean search using AND/OR was conducted: ("participatory design" and

"co-design" and "design process" and " vision impairment" or "blind" or "legally blind"). The thread actions were to select the papers relevant to PD and children with VIs. However, we only included papers and articles if the following criteria were satisfied:

- The involvement of children with VIs in the design process of technology was the aim of the work.
- Mainly focus on children with VIs rather than adults.
- Description of the design process approach was followed rather than mention the PD approach.

When the above criteria were applied, a total of 5 research papers were selected. These articles have investigated the participation of children with VIs during the process of technology design.

## 6. ANALYSIS AND FINDINGS

In this part of the study, we will discuss some common attributes of the related literature: (1) Identifying the domain of the study, (2) Identifying the design approach and the role of children with Vis during the design process, and (3) indicating the detail PD processes such as, stages and activities. Table 4 shows the analysis of the paper's attributes before commencing analysis.

**Table 4**: Analysis of the paper's attributes.

| Ref | Domain | Design approach | The role in the design | Design process |
|---|---|---|---|---|
| [47] | Educational Technology | PD | Informant | • Interviews<br>• Observations |
| [48] | Education Technologies | CoD | Design partner | Workshop<br>• Introduction and participants presentations<br>• Interactive panel discussions:<br>• Break-out sessions and focus group activities<br>• Explorations of examples<br>• Hands-on prototyping<br>- Experience sharing<br>- Wrap-up session<br>- Documentation<br>• Workshop summaries. |
| [49] | Multisensory storytelling technologies | CoD | Design partner | workshops<br>• Increasing old-style storybooks.<br>• Upcoming storytelling tools.<br>• Mapping the story with an early prototype.<br>• Characters.<br>• Sequencing the story with a second prototype.<br>Field study |
| [5] | Inclusive technology | CoD | Design partner | Field study<br>• Identifying challenges<br>Workshop 1: Joint Storytelling<br>• Multisensory Ideas for Joint Storytelling<br>• A tool for Joint Story Map<br>Workshop 2: Independent Mobility and Exploration<br>• Methods, Structure, and Procedure<br>• Body storming<br>• Multisensory Crafting |
| [50] | Voice User Interfaces design | PD | Design partner | Focus group discussions<br>• Discussions with experts:<br>- Educators<br>- Staff<br>• Body storming<br>• The body storming session with a whole class.<br>- Simulating a lesson<br>- Sharing and reflecting on learning aids<br>- Simulating mobility<br>Small Group Discussions. |

As shown in table 4, there are a different number of processes have been used with VIs children. However, there is some similarity between attributes and themes and activities. However, our analysis has identified initial results based on the found in table 4 as the following:

- The workshop is the primary process among all the PD Process.
- Low fidelity prototype is used to turn the design mockups into live prototypes.
- The child lives with VIs can play the role of a design partner during the design process.
- The co-designing was done with the involvement of children with mix vision ability.
- Storyboard, storytelling, and body storming are a powerful tactic for involving children with VIs during the design process.
- Existing literature focused purely on the technology design more than the design methodology for including children with VIs into the process of technology design.
- Assistive technology and educational technology are the almost all outcomes of the projects described in the literature.

## 7. DISCUSSION

PD offers a set of evolving conceptual and practical tools that can support the successful engagement of users in the design process. Additionally, in those methods, users are treated as experts of their own domain, where designers are responsible for facilitating the process to access the user's experiences in a creative way. When children are being involved in the design process, they should participate as a full member of the team, and their opinions and ideas are valued. The power gap between adult designers and children during the design process was discussed. Finding a way to balance between controlling as an organizer and participant at the same time was challenging when suggestion and gathering ideas.

Moreover, it can be challenging to create a fully level power structure within the design group involving both adults and children because children are used to following adults' rules. Allowing the children to have a voice in the design brings more value to the design. This is why Dindler, Iversen, and Doorn look at the child as an icon in the PD process. This also helps us have a better fundamental understanding of learning environments and abilities. In order to co-design with children where they are the main driver of the process, adult designers should be able to create an environment where children and adult designers can share knowledge dynamically. Using PD to Involve children in the design process is giving them the right to have a voice in the design activities of products and services that are essential in their lives.

The CCI community interest in investigating roles can children play during the design process with emphasizing the importance of invited children into the early stages design process begin with ideation. However, there are other parts of the process of design rarely admitted, such as their ability to make decisions, forms of engagement, the form of dialogue, the level of contributing, and form of collaboration.

Table 4 shows that the design partner role was successful works with VIs children, where children can make a move between the roles of design during the design process. In terms of outcome categories listed in Table 4 also, there is on distinctly different from conventional PD approaches, when the design process takes place in the design partnering form. However, we can see a difference in the setting of design activities, tools and engaging children with VIs, when researchers involve children with mix vision ability during the design process where children can learn of each other.

Since the PD is highlighting the skills and ability children obtain out of participation. That may be helping to bridges the divide between adult designers and a group of users who have life-worlds and far away from the eyes of designers such as children with VIs who are facing difficulties regarding cognitive development, communications, and physical orientations, close interactions, lack of sensory stimulation, the environment , culture and social engagement [47]. However, the engagement of legally and totally blind children in the PD process seems to be ignored by designers and researchers.

## 8. CONCLUSION

In conclusion, involving children in the technology design process has provided beneficial input for the design process and has created a deeper understanding of experiences and outcomes for children. Co-designing with children encourages and challenges adult designers and children to work together to design products and services by allowing target users to obtain new knowledge based on a sharing experience. However, the engrossment of children with VIs in the process of technology design allows them to express themselves using means that are familiar to them, as well as enables adult designers and researchers to explore the future of products and services aimed at children with VIs.

In the future, it is significant to comprehend how to engage children with VIs into the PD process. As well as investigate what roles children with VIs can play during the design process as the main drivers. This is in addition to what factors adult designers need to be aware of during the design process with children with Vis as well as what kind of means are needed for designing and prototyping.

## ACKNOWLEDGMENT

We thank and acknowledge, Imam Mohammad Ibn Saud Islamic University, Riyadh, Saudi Arabia, and Faculty of Computer Science and Information Technology, University

Putra Malaysia (UPM), Malaysia, for sponsoring and financial support this research.

**REFERENCES**


[1] **WHO | Vision impairment and blindness**, *WHO*, 2017. [Online]. Available: http://www.who.int/mediacentre/factsheets/fs282/en/. [Accessed: 10-Mar-2018].

[2] G. Vivanti, E. Duncan, G. Dawson, and S. J. Rogers.**Facilitating Learning Through Peer Interactions and Social Participation**, in *Implementing the Group-Based Early Start Denver Model for Preschoolers with Autism*, Cham: Springer International Publishing, 2017, pp. 87–99. https://doi.org/10.1007/978-3-319-49691-7_7

[3] E. Freeman, G. Wilson, S. Brewster, G. Baud-Bovy, C. Magnusson, and H. Caltenco.**Audible Beacons andWearables in Schools: Helping Young Visually Impaired Children Playand Move Independently**, in *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems - CHI '17*, 2017, pp. 4146–4157. https://doi.org/10.1145/3025453.3025518

[4] J. A. Bardin and S. Lewis.**A Survey of the Academic Engagement of Students with Visual Impairments in General Education Classes**, *Journal of Visual Impairment & Blindness*. 2019.

[5] O. Metatla and C. Cullen.**"Bursting the Assistance Bubble": Designing Inclusive Technology with Children with Mixed Visual Abilities**, *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems.* ACM Press, New York, New York, USA, pp. 1–14, 2018. https://doi.org/10.1145/3173574.3173920

[6] S. M. Branham and S. K. Kane.**Collaborative accessibility: How blind and sighted companions co-create accessible home spaces**, in *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems - CHI '15*, 2015, pp. 2373–2382.

[7] O. Metatla, N. Bryan-Kinns, T. Stockman, and F. Martin.**Designing with and for people living with visual impairments: audio-tactile mock-ups, audio diaries and participatory prototyping**, *CoDesign*, vol. 11, no. 1. pp. 35–48, 2015.

[8] O. Metatla, F. Martin, A. Parkinson, N. Bryan-Kinns, T. Stockman, and A. Tanaka.**Audio-haptic interfaces for digital audio workstations: A participatory design approach**, *Journal on Multimodal User Interfaces*, vol. 10, no. 3. Springer International Publishing, pp. 247–258, Sep. 2016. https://doi.org/10.1007/s12193-016-0217-8

[9] M. Kyng.**Bridging the Gap Between Politics and Techniques: On the next practices of participatory design**, *Scandinavian Journal of Information Systems © Scandinavian Journal of Information Systems*. 2010.

[10] B. Westerlund, S. Lindqvist, W. Mackay, and Y. Sundblad.**Co-design methods for designing with and for families**, *PROCEEDINGS FROM THE EUROPEAN ACADEMY OF DESIGN 5*, no. April. 2003.

[11] N. Bevan.**Criteria for selecting methods in user-centred design**, in *CEUR Workshop Proceedings*, 2009, vol. 490.

[12] A. N. Douglas Schuler.***Participatory Design: Principles and Practice*s**. CRC / Lawrence Erlbaum Associates, 1993.

[13] J. Heron.**Co-Operative Inquiry: Research into the Human Condition**. SAGE Publications Ltd, 1995.

[14] C. Magnusson, P. O. Hedvall, and H. Caltenco.**Co-designing together with persons with visual impairments**, in *Mobility of Visually Impaired People: Fundamentals and ICT Assistive Technologies*, Cham: Springer International Publishing, 2017, pp. 411–434. https://doi.org/10.1007/978-3-319-54446-5_14

[15] E. B.-N.Sanders.**From user-centered to participatory design approaches**, 2002, pp. 1–8.

[16] T. Mattelmäki and F. Sleeswijk Visser.**Lost in Co-X: Interpretations of Co-design and Co-creation**, in *Proceedings of IASDR2011, the 4th World Conference on Design Research*, 2011, pp. 1–12.

[17] R. H. Jellema.**Variable Shift and Alignment**, in *Comprehensive Chemometrics*, vol. 2, 2010, pp. 85–108. https://doi.org/10.1016/B978-044452701-1.00104-6

[18] M. J. Muller.**Participatory design: the third space in HCI**, in *Human-computer interaction: Development process*, vol. 4235, 2003, pp. 165–185.

[19] J. C. Read, D. Fitton, and M. Hortton.**Giving ideas an equal chance: inclusion and representation in participatory design with children**, in *Proceedings of the 2014 conference on Interaction design and children - IDC '14*, 2014, pp. 105–114.

[20] M. L. Guha, A. Druin, and J. A. Fails.**Cooperative Inquiry revisited: Reflections of the past and guidelines for the future of intergenerational co-design**, *International Journal of Child-Computer Interaction*, vol. 1, no. 1. Elsevier, pp. 14–23, Jan. 2013.

[21] R. Beale, J. C. Read, N. Iivari, E. Mazzone, and R. Tikkanen.**Considering context, content, management, and engagement in design activities with children**, in *Proceedings of the 9th International Conference on Interaction Design and Children - IDC '10*, 2010, p. 108.

[22] A. Druin.**The role of children in the design of new technology**, *Behaviour and Information Technology*, vol. 21, no. 1. pp. 1–25, 2002. https://doi.org/10.1080/01449290110108659

[23] M. Landoni, E. Rubegni, E. Nicol, and J. Read.**How Many Roles Can Children Play?**, in *Proceedings of the The 15th International Conference on Interaction Design and Children - IDC '16*, 2016, pp. 720–725. https://doi.org/10.1145/2930674.2932222

[24] A. Druin.**The design of children's technology.** Morgan Kaufmann Publishers Inc., 1998.

[25] M. L. Guha, A. Druin, G. Chipman, J. A. Fails, S. Simms, and A. Farber.**Working with young children as technology design partners**, *Communications of the ACM*, vol. 48, no. 1. ACM, p. 39, Jan. 2005. https://doi.org/10.1145/1039539.1039567

[26] F. Van Doorn, P. J. Stappers, and M. A. Gielen.**Children as co-researchers in design: Enabling users to gather, share and enrich contextual data**, 2016.

[27] O. S. Iversen, R. C. Smith, and C. Dindler.**Child as Protagonist: Expanding the Role of Children in Participatory Design**, 2017, pp. 27–37. https://doi.org/10.1145/3078072.3079725

[28] R. Hart.**Children's Participation from Tokenism to Citizenship**, vol. 53, no. 9. 1992.

[29] A. Large, V. Nesset, J. Beheshti, and L. Bowler.**"Bonded design": A novel approach to intergenerational information technology design**, *Library and Information Science Research*, vol. 28, no. 1. JAI, pp. 64–82, Mar. 2006. https://doi.org/10.1016/j.lisr.2005.11.014

[30] J. C. Read, P. Gregory, S. J. MacFarlane, B. McManus, P. Gray, and R. Patel.**An investigation of participatory design with children-informant, balanced and facilitated design**, *Interaction Design and Children*, no. January. pp. 53–64, 2002.

[31] Y. Kafai.***Minds in Play: Computer Game Design as a Context for Children's Learning***, vol. 101, no. 1. L. Erlbaum Associates, 1995.

[32] S. Hussain.**Empowering marginalised children in developing countries through participatory design processes**, *CoDesign*, vol. 6, no. 2. Taylor & Francis, pp. 99–117, Jun. 2010.

[33] P. Kirby, C. Lanyon, K. Cronin, and R. ***Sinclair.Building a Culture of Participation: Handbook.*** 2003.

[34] J. Vines, R. Clarke, T. Leong, J. McCarthy, O. S. Iversen, P. Wright, and P. Olivier.**Invited SIG - participation and HCI**, in *Proceedings of the 2012 ACM annual conference extended abstracts on Human Factors in Computing Systems Extended Abstracts - CHI EA '12*, 2012, p. 1217. https://doi.org/10.1145/2212776.2212427

[35] S. Hussain.**Empowering marginalised children in developing countries through participatory design processes**, *CoDesign*, vol. 6, no. 2. pp. 99–117, Jun. 2010.

[36] P. Kirby, C. Lanyon, K. Cronin, and R. Sinclair.**Building a Culture of Participation: Research Report**, 2003.

[37] A. Druin.**The role of children in the design of new technology, Behaviour & Infirmation Technology**, *Behaviour & Information Technology*, vol. 21, no. 1. pp. 1–25, 2002.

[38] C. Frauenberger, J. Good, and A. Alcorn.**Challenges, opportunities and future perspectives in including children with disabilities in the design of interactive technology**, in *Proceedings of the 11th International Conference on Interaction Design and Children - IDC '12*, 2012, p. 367. https://doi.org/10.1145/2307096.2307171

[39] J. McElligott and L. van Leeuwen.**Designing sound tools and toys for blind and visually impaired children**, in *Proceeding of the 2004 conference on Interaction design and children building a community - IDC '04*, 2004, pp. 65–72.

[40] C. Jones, L. McIver, L. Gibson, and P. Gregor.**Experiences obtained from designing with children**, *Interaction Design and Children*. ACM Press, New York, New York, USA, pp. 69–74, 2003. https://doi.org/10.1145/953536.953547

[41] L. C. L. de Faria Borges, L. V. L. Filgueiras, C. Maciel, and V. C. Pereira.**The life cycle of a customized communication device for a child with cerebral palsy: contributions toward the PD4CAT method**, *Journal of the Brazilian Computer Society*, vol. 20, no. 1. pp. 1–23, Dec. 2014.

[42] V. Henderson, S. Lee, H. Brashear, H. Hamilton, T. Starner, and S. Hamilton.**Development of an American sign language game for deaf children**, *Proceedings of IDC 2005*. ACM Press, New York, New York, USA, pp. 70–79, 2005.

[43] L. Benton.**Participatory Design and Autism: Supporting the participation, contribution and collaboration of children with ASD during the technology design process**, University of Bath, 2013.

[44] L. E. Potter, J. Korte, and S. Nielsen.**Seek and sign: An early experience of the joys and challenges of software design with young deaf children**, in *Proceedings of the 23rd Australian Computer-Human Interaction Conference on - OzCHI '11*, 2011, pp. 257–260. https://doi.org/10.1145/2071536.2071577

[45] A. Al-Wabil, E. Meldah, A. Al-Suwaidan, and A. AlZahrani.**Designing educational games for children with Specific Learning Difficulties: Insights from involving children and practitioners**, in *Proceedings - 5th International Multi-Conference on Computing in the Global Information Technology, ICCGI 2010*, 2010, pp. 195–198. https://doi.org/10.1109/ICCGI.2010.43

[46] J. Waddington, C. Linehan, K. Gerling, K. Hicks, and T. L. Hodgson.**Participatory Design of Therapeutic Video Games for Young People with Neurological Vision Impairment**, in *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems - CHI '15*, 2015, pp. 3533–3542.

[47] O. Metatla.**Uncovering Challenges and Opportunities of Including Children with Visual Impairments in Mainstream Schools**, *British HCI 2017*. pp. 1–7, 2017. https://doi.org/10.14236/ewic/HCI2017.102

[48] O. Metatla, M. Serrano, C. Jouffrais, A. Thieme, S.

Kane, S. Branham, É. Brulé, and C. L. Bennett.**Inclusive Education Technologies: Emerging Opportunities for People with Visual Impairments**, in *Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems - CHI '18*, 2018, pp. 1–8.

[49] C. Cullen and O. Metatla.**Multisensory storytelling: a co-design study with children with mixed visual abilities**, in *Proceedings of the 17th ACM Conference on Interaction Design and Children - IDC '18*, 2018, pp. 557–562.
https://doi.org/10.1145/3202185.3210775

[50] O. Metatla, A. Oldfield, and T. Ahmed.**Voice User Interfaces in Schools : Co-designing for Inclusion With Visually-Impaired and Sighted Pupils**, *ACM Reference Format: Oussama Metatla*. ACM, p. 15, 2019.
https://doi.org/10.1145/3290605.3300608