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5 Usability and accessibility of toys and technologies for play for children with disabilities: Scoping review of guidelines and tools.

Abstract. For creating play opportunities for children with disabilities toys, games, apps, robots, and other technological products are as important as for typically developing children. Above all the products have great potential for inclusive play. However, many anecdotes from clinical practice and data from research show the challenges in finding and choosing a suitable toy or technology, in evaluating these play objects on their usability and accessibility for given children, in designing and producing a toy usable for all children. This paper describes the scoping review carried out to investigate: (1) which guidelines and tools regarding usability and accessibility of toys and technologies for play for children with disabilities exist, (2) what is their possible use for different stakeholders involved in play for children with disabilities, (3) what are the strengths and the weaknesses of the guidelines and tools. For this review, sources identified by experts, different databases, and hand-made search results were considered, which yielded to a final set of 15 guidelines on usability and accessibility of toys and technologies for play for children with disabilities that was explored in detail. Each guideline was reviewed by two reviewers using the adapted AGREE II instrument. The review resulted in the selection of 10 guidelines on usability or accessibility of toys and technologies, only 5 had a specific focus on play. For most of the guidelines the rigour of the development and the supporting evidence were not described. Further research and development is needed, as adults involved in play for children with disabilities need support in handling or creating the appropriate toys and technologies.

5.1 Introduction

The importance of play for children's development, well-being, and quality of life is extensively explored and described (Besio, Bulgarelli, & Stancheva-Popkostadinova, 2017). Technological innovations are affecting many aspects of modern life, including play and play environments of children with and without disabilities. However, the impact on the use of toys made of non-standard materials, or including technological devices, is less discussed and researched in text books for diverse stakeholders involved on toys and technologies for play for children with disabilities (e.g., Case-Smith & Clifford O'Brien, 2015; Nathan & Pellegrini, 2010; Pullin, 2009). Bergen and colleagues (2016) mentioned that research on effects of technology-augmented play is still relatively small (Bergen, Davis, & Abbitt, 2016).

Still, important bodies like World Health Organization and UNICEF, emphasize the importance of access to assistive technology for children with disabilities to improve their participation (Borg, Berman-Bieler, Khasnabis, Mitra, Myhill, & Samant Raja, 2015). One of the strategies to facilitate inclusion in play among children with physical disabilities in childcare centres concerns environmental factors, i.e. using a physical setting to enable the child to be included, using different types of toys to facilitate play behaviour and engagement in play, and using the specific play activity to encourage participation in play (Crawford, Stafford, Philips, Scott, & Tucker, 2014). In this perspective, “play [for the sake of play, for the purpose and objective of the play itself and not as a mean for educational or rehabilitative objectives] becomes the privileged mean for creating inclusive contexts and adopting inclusive styles, with respect to any kind of differences, including those related to the possible impairment and to human functioning” (Besio, 2017, pp. 45,47).

Technology has great potential for play of children with disabilities. However, different questions are emerging about toys and technologies for this purpose. Are children, parents, teachers, and therapists supporting these children, aware of different kinds of toys and technologies? Do they know, how to get them and how to use them? How can they evaluate the impact of the play object? What is the evidence supporting the use of a specific toy or technology to enable play? To what extent are designers and engineers developing toys and technologies suitable for all children, including children in the age of 0-18 years with any kind of disability? How can the design and production of an object for play be made accessible and usable? How are scholars investigating the use of toys and technologies for play? What kind of measurements do they use? The list of questions remains open.

In this paper, we focus on usability and accessibility of toys and technologies for play for children with disabilities and above questions upon these topics will be addressed. Usability is defined as “the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use” (ISO 9241-11:2018).

The aspects of the concept include:

- a user, i.e. an individual who accesses or interacts with a system;
- effectiveness, i.e. accuracy and completeness of achieving user-specific goals;
- efficiency, i.e. the resources expended in relation to effectiveness;
- satisfaction, i.e. freedom from discomfort, and positive attitudes towards to use of the product;
- context, i.e. physical and social environment of a system use, including users, tasks, equipment and materials.

The concept of accessibility is inevitably related to usability. For toys and technological play objects accessibility is so important that both concepts should be used along. Accessibility is defined as “the extent to which products, systems, services, environments and facilities can be used by people from a population with

the widest range of characteristics and capabilities to achieve a specified goal in a specified context of use” (ISO 9241-11:2018, p. 3) Accessibility involves both ease of use and success of use (ISO/IEC Guide 71:2014) .

In this paper the following questions are investigated:

- Which guidelines and tools regarding usability and accessibility of toys and technologies for play for children with disabilities exist?
- What is their possible use for different stakeholders involved in play for children with disabilities?
- What are the strengths and the weaknesses of the identified guidelines and tools?

To answer these questions, we have considered the following definition for guideline: “information intended to advise people on how something should have been done or what something should be”, whereas tool is defined as “something that helps you to do a particular activity” as described in the Cambridge English Dictionary. In this case the activity concerns usability and accessibility of toys and technologies for play for children with disabilities the concept of children with disabilities should be interpreted as persons in the age of 0 to 18 years with all kind of disabilities, as stated on in the Convention on the Rights of the Child by UNICEF (1989). The stakeholders we have considered are parents, professional caregivers, designers, and people interested in developing this kind of toys as hobbyists (“makers”). They have different purposes, and may profit of each guideline in different ways, if any.

5.2 Method

The current paper is one of the outcomes of the COST Action TD1309 “LUDI – Play for Children with Disabilities” (2014-2018)²⁹, a network of more than 100 researchers and practitioners coming from 32 European countries and devoted to the theme of play and toys, technologies for children with disabilities.

5.2.1 Data collection

Having defined the adopted terminology, the methodology for this review is discussed in this section. A scoping study was chosen as an exploratory one in order to include all sources and data that can be used to identify gaps in the existing research (Arksey & O’Malley, 2005). The study started by identifying four sources of information: the LUDI database, documents about the topic shared by LUDI members, results from extensive search on selected databases, and hand search.

²⁹ For more detailed information about the COST Action LUDI, please refer to: <https://www.cost.eu/actions/TD1309/#tabs|Name:overview> and to: <https://www.ludi-network.eu/>

LUDI database was expected to provide information on tools and guidelines used in interventions and research projects. A working group of researchers and practitioners within LUDI project have created a database of assistive technologies to support play for children with disabilities (stored at: <http://ludi.utad.pt/>). Devices, services and contexts for play for children with disabilities were collected. Table 5.1 reports the set of attributes recorded in the database. The elements marked in bold with (*) are explicitly aimed at collecting sources to evaluate usability, accessibility and effectiveness of devices, services and context for play for children with disabilities.

Table 5.1: Structure of the LUDI database records.

Items of the database	Example of contents
Name of play experience	
Type of project	Intervention, finished or ongoing research
Summary	Target group, aims, kind of activities, Play Experience by AT used (devices, services and contexts), play experiences and results
Description of the play experience	Low-tech, high-tech products, services and contexts for play. Intended user(s), intended target group(s), manufacturer/ developer, reference
The context of use	Home, school, rehab centre or other environments
Type of play	According to LUDI classification of types of play (Bulgarelli & Bianquin, 2017)
Objectives on play according to ICF-CY	Play for the sake of play with different objectives/codes Play like activities with different objectives/code
Participants	Number, chronological and developmental age, type of disabilities according to the LUDI classification
Explanation	Explanation of the adult about the use of low-tech, high-tech devices, services or contexts Involvement of adult(s) and his/her role
Evaluation	Evaluation of objectives and the outcome measures (*) used for this, including availability of outcome measure, publisher, website, contact person were collected as shown in Figure 5.1
Summary of achievements	Achieved effects
References to the intervention or research project	List of published materials referring to the specific entry of the database
Keywords	Keywords of the described intervention or research. As well reference of play system with similar keywords
Additional information	Information on guidelines/tool for usability and accessibility of toys and technologies can be posted (*) .

The screenshot shows a web interface for the LUDI database. At the top, there is a navigation bar with links for LUDI, AT, VIDEO, MANAGE, About, and Contact. A search bar contains the text 'Search Play Experience!' and a 'Search' button. The user's name 'Hello name.jansens' is visible on the right. The main content area is titled 'Insert data about Play Experience by AT for play'. On the left, there is a sidebar with icons and labels for 'Summary', 'Play Experience by Assistive Technology', 'Context', 'Type of Play', 'Objectives', 'Participant', 'Explanation', and 'Evaluation'. The 'Evaluation' section is currently active. The main form area contains the following text:

Evaluation of objectives and outcome measures

Description of outcome measure(s)

- Observation by professional/researcher providing the play experience
- Observation by other professional/researcher
- Video analysis
- Feedback from client/parents/professionals
- (validated and reliable) outcome measures like tests, self-reports of client/system, questionnaires

Information about availability of outcome measure: publisher, website, contact person

Below this text is a large empty text input field.

Figure 5.1: Evaluation of objectives and the outcome measures as reported in the LUDI database.

Secondly, members of LUDI were sharing the documents and resources that they created or worked with. These resources were about evaluating toys and technologies for play for children with disabilities, in particular about usability and accessibility.

Besides the so far mentioned resources, it was necessary to search at different databases and key journals to make the systematic review process sound.

In February 2018, searches were made on two online databases: DiZ and PubMed. DiZ³⁰ is an online database of Zuyd University, which consists of 34 different databases. The search strategy was based on a PICO question (Schardt, Adams, Owens, Keitz, Fontelo, 2007), namely: ‘Which guideline(s) exists on usability and accessibility of toys and technology for play for children with disabilities?’. The search strategy was first used on PubMed and then converted for the DiZ. For the search on PubMed, the patient, intervention and outcome categories were filled with MESH-terms and alternative terms, considering spelling variations and synonyms, to cover the complete scope of published articles. MESH-terms were also used as free terms, to make sure the most recently published articles were included as well. For patient, this included the MESH-term “Disabled Children” and the free terms “handicapped child*”, “children with disabilities”, “child with disability”, “disabled child*”; for intervention, the MESH-term “Play and Playthings” and the free terms “toys for play”, “technologies for play”, “technology for play”, “play technologies”, “play technology”, “APP”, “application” and “robot*” were used and for outcome this included the MESH-term “Architectural Accessibility” and the free terms “accessib*” and “usab*”. The search was restricted to articles written in English or Dutch, published from November 2007, with full text availability. The date November 2007 was chosen as the start

³⁰ Please, check: <https://bibliotheek.zuyd.nl/en/home>

date due to the WHO publication at 24 October 2007 of a new internationally agreed standard for documenting the health of children and youth: ICF-CY, a commonly used framework in international research where toys and technologies are incorporated in the environmental factors. The search was carried out in February 2018 (Van der Hoef, 2018).

To be as comprehensive as possible, key journals, GoogleScholar and reference lists of relevant articles were hand-searched. Among these, the reference list of the PhD thesis “*Empowering Interactive Technologies for Children with Neuro-Developmental Disorders and their Caregivers*” by Dr Mirko Gelsomini (2018), as he collected hundreds of references on the topic.

5.2.2 Reviewing process

Relevant studies, documents, website information were selected on three levels by three or more reviewers. The first selection was made on title level, the second selection on abstract/summary level, the third selection on full text level, based on the in- and exclusion criteria.

Regarding inclusion criteria, sources (documents, scientific articles, websites) were included when they concerned all of the following aspects:

1. children in the age of 0-18 years old;
2. children with any kind of disability/handicap or a combination of disabilities/handicaps;
3. toys or technologies for play in its broadest sense, like APPs, videogames, robots, self-made or self-adapted toys.

Exclusion criteria: sources (documents, scientific articles, website information) were excluded when:

1. focused on the evaluation of the accessibility or the usability of one example of a toy or technology for play. This criterion was used because this is a search for guidelines, standards, tools or recommendations for guidelines on usability and/or accessibility in general, not just for a single item.
2. the toys and/or technologies mentioned in the sources were used to improve physical or academic skills, since the guidelines and tools should concern play for the sake of play, and not on play-like activities (Besio, 2017).

More than 30 reviewers were involved to evaluate full texts of the retrieved documents. The process was divided into three stages: (1) a quick scan based on title and abstract, (2) full-text scan, (3) formal evaluation with AGREE II instrument. For stage 1 and 2, a quick scan taxonomy was developed, discussed and accompanied with clear instructions shown in Appendix 1. Sources were allocated to reviewers randomly, however bearing in mind the professional background assuring each document was

reviewed by at least one person with product-oriented background and one with child-oriented background.

After selection at title, abstract, and full text level, the results were subject to an in-depth reviewing process. For this aim, different methodologies were considered. The AGREE II instrument (Brouwers et al., 2013 updated version), a tool for reviewing clinical guidelines, was chosen, adapted for the objectives of this review and piloted, presented in Appendix 2.

If the reviewers disagreed about the document meeting the criteria, more reviewers were involved.

5.3 Results

The records of LUDI database (N = 54) were describing mostly qualitative, not validated evaluations of toys and technologies like observations and interviews by researcher/therapist or members of the team. The evaluation focus, as stated in the record, was often on user experiences, observing his/her behaviour and asking feedback from the user, either directly, when possible, or to intermediaries or caregivers. As no record had detailed information about their research methodology e.g. any observation guide, interview guide or detailed information about video analysis was given, it was not possible to draw any conclusion regarding the rigour.

Only the following three records from the LUDI database were qualified for the in-depth review:

- “Juego, juguetes y discapacidad. La importancia del diseño universal”: there is an English version available of this guideline/tool (Costa et al., 2007).
- “Does it work?” A framework to evaluate the effectiveness of a robotic toy for children with special needs. (Ferrari, Robins, & Dautenhahn, 2010).
- “Towards a New Measure of Playfulness: The Capacity to Fully and Freely Engage in Play” (Sandersons, 2010).

The second source, i.e., the LUDI project participants’ collection of guidelines and tools on usability and accessibility of toys and technology for play for children with disabilities, yielded 59 documents or references to websites. In the first selection duplicates were removed. Secondly, 45 documents were reviewed with the quick scan taxonomy by 3 or more reviewers with technology-product oriented or child-oriented background. This process revealed 20 potentially interesting documents. Reasons for excluding the other 25 sources were diverse: measurement of a child abilities only, not referring technologies for play, focus on assistive technologies not referring to play support, list of toys without usability or accessibility aspects or sources explaining general principles of interaction design. The third source, the research databases, generated a total of 89 articles. The fourth source, i.e. hand-searching in key journals, reference lists of key journals and the 622 references of the PhD thesis of Gelsomini

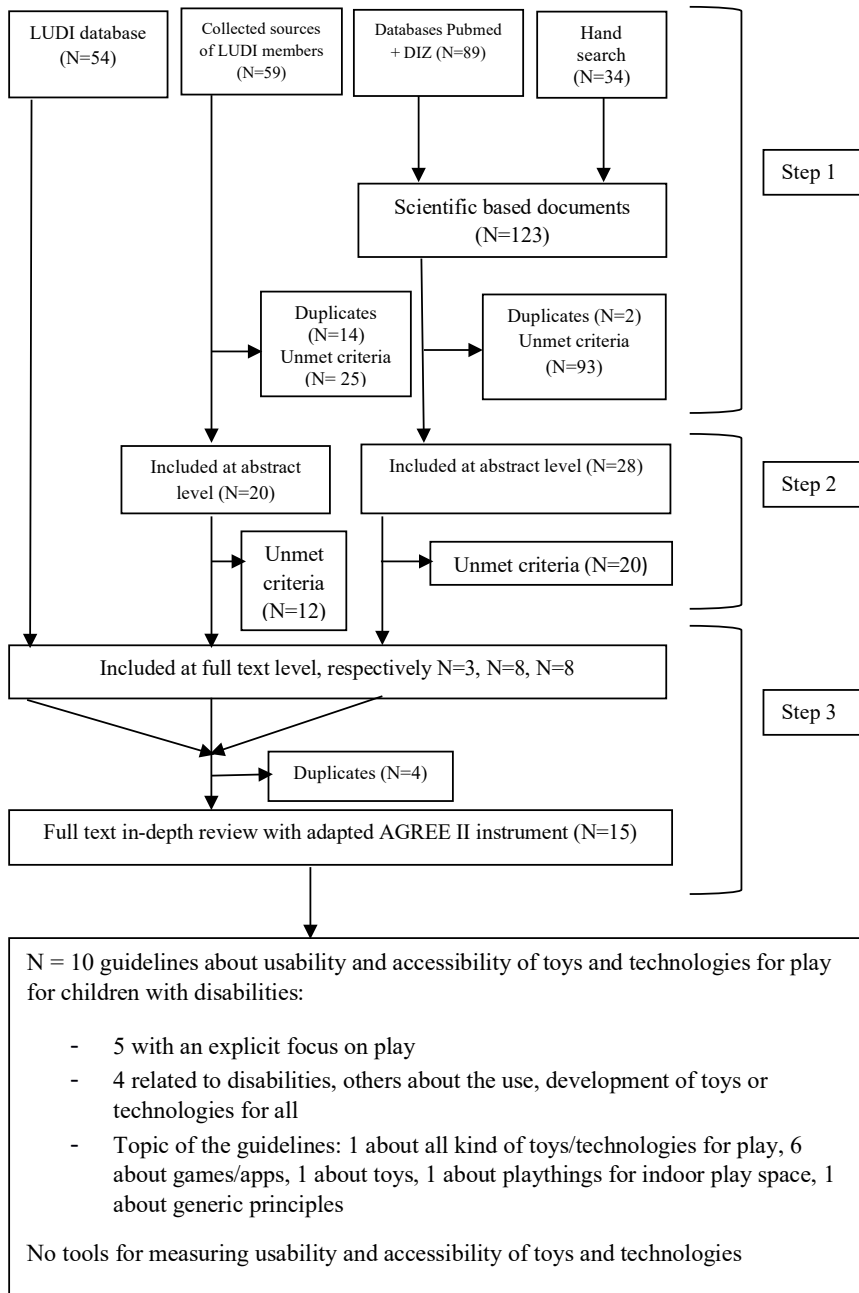


Figure 5.2: Reviewing process.

(Gelsomini, 2018), added 34 more articles to the next review stage. The output from databased and hand search was combined and yielded in total 123 items. At title/abstract level of the study selection process, 2 documents were excluded due to duplication, 93 documents due to the criteria that the mentioned toy/technology was not for play or was used to improve physical or academic skills in a play-like activity or had a focus on the accessibility of healthcare or of a public building. Applying in- and exclusion criteria at abstract level limited the articles found to the final 8 included documents.

The four different sources of data collection revealed a total of 15 guidelines/tools on usability and accessibility of toys and technologies for play for children with disabilities, after expelling 4 duplicates. These 15 documents were evaluated in-depth with the adapted AGREE II instrument. These data can be consulted at <https://www.dropbox.com/sh/iafjr1mj01zgesf/AAAbw5KBEv6jKAZ543TSV9tHa?dl=0>

Table 5.2 presents a summary of the review data with a justification for exclusion and whether the guideline/tool is a suitable guideline for this review aim or can be part of a guideline on usability and accessibility of toys and technologies for play for children with disabilities as described in the research questions in the introduction section.

As a result of the AGREE II evaluation phase, the following guidelines are recommended by LUDI as guidelines to support usability and accessibility of toys, games indoor play things or for all kind of play objects for play for children with disabilities:

- Toys, games and disabilities. The importance of a universal design (*) (Costa et al., 2007)
- Inclusive indoor play: An approach to developing inclusive design guidelines (Mullick, 2013)
- Designing universally accessible games (Grammenos, Savidis, & Stephanidis, 2009)
- Guidelines to promote play opportunities for children with disabilities. Let's play projects.
- Game accessibility – A survey (*) (Yuan, Folmer & Harris, 2011)

Five other guidelines are not focusing explicitly on play but can be used for creating play opportunities as well, and therefore recommended by LUDI:

- Game accessibility guidelines (<http://gameaccessibilityguidelines.com/>)
- Highlights of Inclusive Design for App Development (<https://tech.beitissie.org.il/en/highlights-of-inclusive-design-for-app-development/>)
- APPLication guidebook: 7 easy steps to making your app accessible (*)
- <http://en.beitissie.org.il/kb/item/7-easy-steps-to-making-your-app-accessible/>
- The Principles of Universal Design (https://projects.ncsu.edu/design/cud/about_ud/udprinciplestext.htm)
- Includification. A practical guide to game accessibility (*) (<https://accessible.games/includification/>)

Table 5.2: Revision of 15 guidelines/tools on usability and accessibility of toys and technologies for play for children with disabilities.

N	Name of guideline/tool Documents available via	Targeted users	Goal	Weaknesses	Conclusion by reviewers	Inclusion
1	Game accessibility guidelines http://gameaccessibilityguidelines.com/	For game developers	To support the development of games for people with disabilities	Rigour of development of the guideline and supporting evidence is lacking	No clear focus on play and not a clear focus on children However the guideline has interesting information for developing games for aspects of design, i.e. cognition, mobility, motor skills, vision, speech, hearing and general	Yes
2	Highlights of Inclusive Design for App Development https://tech.beitissie.org.il/en/highlights-of-inclusive-design-for-app-development/	For APP developers	To support the development of accessible apps for people with disability	Rigour of development of the guideline and supporting evidence is lacking	Not explicitly for play or children but might be suitable for developing or assessing apps for play for children with disabilities Guideline is comprehensive and can be understand easily, takes different aspects in consideration, i.e. motor, auditory, cognitive, orientation, visual, text & language, content, general	Yes
3	Application guidebook: 7 easy steps to making your app accessible http://en.beitissie.org.il/kb/item/7-easy-steps-to-making-your-app-accessible/	For mobile app developers	To support the development of accessible apps for people with visual impairment	Rigour of development of the guideline and supporting evidence is lacking	No clear focus on play. This guidebook supports evaluation and design of apps for people with visual impairments Guideline is easy to use as presented clearly and well-ordered	Yes

Continued **Table 5.2:** Revision of 15 guidelines/tools on usability and accessibility of toys and technologies for play for children with disabilities.

N	Name of guideline/tool Documents available via	Targeted users	Goal	Weaknesses	Conclusion by reviewers	Inclusion
4	The Principles of Universal Design https://projects.ncsu.edu/design/cud/about_ud/udprinciplestext.htm	For architects, designers, engineers It can also be used by researchers and professionals	To evaluate existing toys, products, already available on the market and to check if they are accessible and usable for all children	Rigour of development of the guideline, and supporting evidence is lacking	No clear focus on play neither on children neither on challenges related to disabilities However, the principles are important for understanding the rationale about inclusive play design and user-centred design	Yes
5	Toys, games and disabilities. The importance of a universal design (Costa et al., 2007)	For toy industry, for parents, Is also useful for designers, professional also working with children for choosing and adapting toys.	To inform about problems that persons with disabilities have to face when accessing and playing with toys	The recommendations are based on theory about play of children with different disabilities and on research about accessibility of toys	Focus on toys for children with hearing, visual and motor impairment Concrete recommendations for toys for children with different kind of disabilities, for creating toys accessible for all children	Yes
				The develop mental process is not clearly described. There is no information about supporting evidence		

Continued **Table 5.2:** Revision of 15 guidelines/tools on usability and accessibility of toys and technologies for play for children with disabilities.

N	Name of guideline/tool Documents available via	Targeted users	Goal	Weaknesses	Conclusion by reviewers	Inclusion
6	Let's play http://letsplay.buffalo.edu Not retrievable anymore	For parents with children under the age of 3	For the development and maintenance of lending AT library To replicate a library for toys, assistive technology for children under the age of 3	Just some few flaws in the developmental process	Guidelines for development, use and maintenance of a lending AT library for parents with children under the age of 3	No
7	Assistive Technology (AT) Resource Guide https://www.ocali.org/up_doc/AT_Resource_Guide_2013.pdf	For professional teams in school	For assessment and provision of AT support to students with disabilities Well documented for application processes	Just some few flaws in the developmental process	It's a guideline for all involved in the assessment for AT of students with disabilities in school (section 5). Clear, comprehensive, providing practical tools for implementation It's not a guideline/tool about play. Focus on the process of selecting and evaluating AT use, not on the type of technologies or their usability/accessibility	No

Continued **Table 5.2:** Revision of 15 guidelines/tools on usability and accessibility of toys and technologies for play for children with disabilities.

N	Name of guideline/tool Documents available via	Targeted users	Goal	Weaknesses	Conclusion by reviewers	Inclusion
8	Incluidification. A practical guide to game accessibility (Drumgoole & Mason, 2012) https://accessible.games/incluidification/	For game developers	For developing accessible games for persons with mobility, vision, hearing and cognitive disabilities	Rigour of development of the guideline and supporting evidence is lacking	No clear focus on play Interesting guideline for game developers with simulation exercises to better understand the situation of persons with mobility, vision, hearing and cognitive disabilities	Yes
9	Toys Safety Directive 2009/48/EC. https://ec.europa.eu/growth/sectors/toys/safety_nl	For manufacturers, trade associations, bodies in charge of the preparation of standards, authorities	To provide guidance on how to ensure that the informations in instructions and warnings is accessible and can be understood	No information about developmental process, its rigour, stakeholder involvement, editorial independence	This document is not a guideline or tool for usability and accessibility of toys and technologies for children with disabilities. It is a guideline on toy safety	No

Continued **Table 5.2:** Revision of 15 guidelines/tools on usability and accessibility of toys and technologies for play for children with disabilities.

N	Name of guideline/tool Documents available via	Targeted users	Goal	Weaknesses	Conclusion by reviewers	Inclusion
10	Inclusive indoor play: An approach to developing inclusive design guidelines (Mullick, 2013) https://www.dropbox.com/sh/5tdwypniskum6o38/AAB-wQREx7RVTVjg_1n9zQH_a?dl=0	For designers	For designing indoor playthings and environments. These guidelines are supported by the outcomes of mixed method research.	Developmental process has little flaws	This article describes the scientific methodology and the design guidelines for inclusive indoor play: for playthings and for environments.	Yes
11	The hierarchy of needs to inclusive design (Fischer Brendler & van der Linden, 2012)	For designer	To study design importance in the development of effectively inclusive products based on Design Emotional approach, allowing children with disabilities to experience playing in the childhood as an instrument for social integration	Literature review with clear methodological description	Not a guideline or tool about usability and accessibility of toys and technology The study proposes a new level of need to model the hierarchy of needs, of Jordan, a model of consumer needs	No

Continued **Table 5.2:** Revision of 15 guidelines/tools on usability and accessibility of toys and technologies for play for children with disabilities.

N	Name of guideline/tool Documents available via	Targeted users	Goal	Weaknesses	Conclusion by reviewers	Inclusion
12	Designing universally accessible games (Grammenos, Savidis, & Stephanidis, 2009) https://www.dropbox.com/sh/5tdwypniskun6o38/AAB-wQREx7RVTVjg_1n9zQH_a?dl=0	For designer of computer games, apps	To apply unified design to the development of universally accessible games followed by recommendations for universal accessible games	Four computer games were created with a two-fold role: to act as both proofs of concept and as case studies They carried out a subjective usability evaluation process with adult participants (ages 19 to 25) and with user experience experts	This paper shows designers in detail how 4 games can be made universally accessible, for all persons, including persons with disabilities, and actively support the right of all people for social interaction and play The recommendations can be applied to other games, also for players under the age of 18	Yes
13	Guidelines to promote play opportunities for children with disabilities. Let's play projects. http://letsplay.buffalo.edu/ not retrievable anymore. Document is available via Dropbox link	For adults as play partner and facilitator of play for children with disabilities	To give recommendations about positioning, communication and social support, selecting or adapting toys, play strategies, and play strategies to switch toys	It is not clear what the evidence base is No information about the developmental process	This guideline seems sensible for creating play opportunities with toys for children with disabilities	Yes

Continued **Table 5.2:** Revision of 15 guidelines/tools on usability and accessibility of toys and technologies for play for children with disabilities.

N	Name of guideline/tool Documents available via	Targeted users	Goal	Weaknesses	Conclusion by reviewers	Inclusion
14	Ableplay toy guide Lekotek (Lavine & The AblePlay Team, 2016)	For parents and other family members	To present toys and options for play activities for children related to 8 categories: Cognitive, Communicative, Emotional, Social, Sensory, Physical, Tech and Adaptive	No information about development process, supporting evidence, editorial independence	Reviews available via https://www.dropbox.com/sh/iafjr1mj01zgesf/AAAbw5KBEv6jKAZ543TSV9tHa?dl=0	No
15	Game accessibility – A survey (Yuan, Folmer & Harris, 2011)	For developers, parents, caregivers, and users	To survey the current state-of-the-art in research and practice in the accessibility of video games	The development process is clearly described and has a strong rigour	This guideline provides strategies for game developers as well as for users, parents, professionals surrounding persons with visual, hearing, cognitive or motor disabilities	Yes
			Information about input devices, selected games and identified strategies for players with motor, hearing, visual or cognitive impairment		The selected games can give inspiration to try out. The strategies identified can support creating inclusive play opportunities	

From these 10 guidelines, 4 (marked with *) are specifically addressing disabilities like hearing, visual, cognitive, motor or mobility impairments.

5.4 Conclusion

This scoping review resulted in recommendation of 10 guidelines on usability and accessibility of toys and technologies for play of children with disabilities. From the 15 guidelines/tools five were excluded as they did not focus on usability and accessibility of toys and technologies for play but on toys safety or setting up a library to lent assistive technology. In this review, no tools for usability and accessibility measurement were found. Most guidelines are focusing on games and apps. No source emerged about usability and accessibility of robots. The majority of the guidelines and tools developed for persons with disabilities are not in particular for children. Play is the focus of five guidelines emerged in this review. One guideline takes play things in an indoor play environment into consideration. In this perspective it is worth mentioning that play environment or contextual factors were not considered as criteria in this study. For most of the guidelines the rigour of the development, the supporting evidence, the process for updating and editorial independence were hardly described.

5.5 Discussion

Although efforts were made to have a transparent and scientifically sound process, this research was challenged in different ways. Cooperation with experts from different countries, with different languages and cultures, with expertise in different professional and scientific fields demands time for understanding, a common mindset and a methodological thorough work. On the opposite, the interdisciplinary and inter-cultural composition of the LUDI Network showed its merits: learning more about each other's profession, background and role in creating inclusive play opportunities for children with disabilities was beneficial for the scientific discussions and work.

Different sources were consulted to find guidelines and tools on usability and accessibility for play for children with disabilities. However, the choice of sources, the keywords and strategies applied cannot guarantee completeness.

Trustworthiness was aimed by using all occasions available to discuss the process, search, review criteria and outcomes with different LUDI members. The composition of the work group was not the same at all meetings and this challenged the process and preconceived outcomes. Each step of the review process was carried out by at least two reviewers, one with expertise in technology and products and one with expertise in supporting children with disabilities in order to increase the interdisciplinary character of research.

The outcomes of this search and review process show the limited resources for assessing usability and accessibility either guiding the developmental process of toys and technologies for play for children with disabilities, and their application. The lack of methodological transparency and therefore accountability of the 10 included guidelines is a concern as well.

Fast technological developments and challenges bringing to the implementation of innovations indicate that further research in this field is required to support designers and engineers in making inclusive toys and technologies as well as to support parents and professionals in applying these toys and technologies to strengthen transparent professional reasoning and, if possible, evidence based practice. There is still work to be done by researchers, innovation managers and policy makers to support play processes in children with disabilities, to cooperate and to exchange expertise. Designing and producing accessible and useable toys and technologies for children with disabilities is often not reality, neither creating inclusive play opportunities for play for the sake of play so that children are in control, can direct the play situation, and, above all, have fun (Westling Allodi & Zappaterra, 2019). Guidelines on usability and accessibility of toys and technologies for play for children, aged 0-18 years with all kind of disabilities might support different stakeholders in creating inclusive toys and technologies and in enabling children in play for the sake of play. However, this scoping review yielded 10 guidelines only, with a limited focus and lacking transparency in the methodological process, and no tools at all.

5.6 Acknowledgements

We would like to thank LUDI Working Group 2 members for their support in different phases of the development of the guidelines (in alphabetic order): Ms Natalia Amelina, UNESCO Institute for Information Technologies in Education in Russia; Ms Nan Cannon Jones, Independent Consultant in UK; Ms Dana Cappel, Beit Issie Shapiro in Israel; Ms Maria Costa, AIJU – Technological Institute for Children’s Products and Leisure Alicante in Spain; Ms Tânia de Jesus Vilela da Rocha, University of Trás-os-Montes and Alto Douro and INESCT/ UTAD in Portugal; Mr Pedro Encarnação, Católica Lisbon School of Business and Economics Universidade Católica Portuguesa in Portugal; Mr Raymond Holt, University of Leeds in United Kingdom; Ms Iolanda Iacono, Glitch Factory in Italy; Mr Antoni Jaume-i-Capó, Universitat de les Illes Balears in Spain; Ms Malgorzata Jedrzejewska-Szczerska, Gdansk University of Technology in Poland; Mr Jari Jessen, Due Jessen Digiplay in Denmark; Mr Vygaudas Juozaitis, Lithuanian College of Democracy in Lithuania; Ms Hatice Kose, Istanbul Technical University in Turkey; Ms Agnieszka Landowska, Gdansk University of Technology, ETI Faculty in Poland; Ms Patrizia Marti, University of Siena in Italy; Ms Veronica Montanaro, University of Malta & TAASC in Malta; Ms Lourdes Moreno, Universidad Carlos III de Madrid in Spain; Mr Mati Mõttus, Tallinn University in Estonia; Ms Noa

Nitzan, Beit Issie Shapiro in Israel; Ms Selda Ozdemir Gazi, University in Turkey; Mr Suat Ozdemir Gazi University in Turkey; Ms Lucía Pérez-Castilla Alvarez Ceapat (Imsero), National Reference Centre for Personal Autonomy and Assistive Technology in Spain; Ms Odile Perino, FM2J, Play Training Centre, Lyon in France; Ms Noemí Rando, AIJU, Technological Institute for Children's Products and Leisure Alicante in Spain; Mr Ben Robins, University of Hertfordshire in United Kingdom; Ms Evelyne Thommen, University of Applied Sciences and Arts in Switzerland; Mr Tim Vanden Hende, Arteveldehogeschool in Belgium; Ms Renée van den Heuvel, Zuyd University of Applied Sciences in the Netherlands; Mr Robin van Kampen, NYOYN International in the Netherlands.

Special thanks to Mirko Gelsomini, former Ph.D student at Politecnico di Milano in Italy and to Manon van der Hoef, former BSc. occupational therapy student at Zuyd University of Applied Sciences in the Netherlands for their significant contribution.

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Appendix I

Review of guidelines and tools on usability and accessibility of toys and technologies for children with disabilities: quick scan taxonomy.

Each record requested the following information:

Document full name + source

Information of original file:

- person who has proposed this document
- what kind of source is it
- what is the aim
- for whom is it developed
- additional comments

Quick scan of document:

- Reviewers' information: name reviewer 1 + background, name reviewer 2 + background, name reviewer 3 + background
- Dimension 1 Type of document: guideline, standard, assessment, research paper, website, other
- Dimension 2 Evaluated features: usability, accessibility, playfulness, enjoyment, user experience, other
- Comments

Decision of each reviewer

- In- or ex-clusion
- Comments

Final decision

- In- or ex-clusion

Appendix II

Adapted version of AGREE II instrument (2013) for LUDI purpose: Reviewing guidelines on usability and accessibility for toys and technologies for play for children with disabilities.

Adaptations made for purposes of this review are marked as follows: **xxx**: information in bold is added information, ~~xxx~~: this criterion is deleted

DOMAIN 1: SCOPE AND PURPOSE

1. The overall objective(s) of the guideline is (are) specifically described.
2. The health question(s) covered by the guideline is (are) specifically described.
Health question: about accessibility and usability, what kind of disability is treated. It is really about a question which will be answered.
3. The population (patients, public, etc.) to whom the guideline is meant to apply is specifically described.

DOMAIN 2: STAKEHOLDER INVOLVEMENT

4. The guideline development group includes individuals from all relevant professional groups
5. The views and preferences of the target population (patients, public, etc.) have been sought. **For the final users: children, aged 0-18 years with all kind of disabilities**
6. The target **users** of the guideline are clearly defined. **About the users of the guidelines, e.g. industry, therapist, teachers, parents, designers, engineers**

DOMAIN 3: RIGOUR OF DEVELOPMENT

7. Systematic methods were used to search for evidence.
8. The criteria for selecting the evidence are clearly described.
9. The strengths and limitations of the body of evidence are clearly described.
Quality of the validation, possible limitations.
10. ~~The methods for formulating the recommendations are clearly described.~~
11. ~~The health benefits, side effects, and risks have been considered in formulating the recommendations.~~
12. There is an explicit link between the recommendations and the supporting evidence. **Recommendations = guidelines/evaluation methods**
13. The guideline has been externally reviewed by experts prior to its publication.
Experts are experts in clinical area, methodological experts, target population's representatives
14. A procedure for updating the guideline is provided.

DOMAIN 4: CLARITY OF PRESENTATION

15. The recommendations are specific and unambiguous.
16. ~~The different options for management of the condition or health issue are clearly presented.~~
17. Key recommendations are easily identifiable. **Structure of document.**
18. The guideline describes facilitators and barriers to its application.
19. The guideline provides advice and/or tools on how the recommendations can be put into practice.
20. ~~The potential resource implications of applying the recommendations~~
21. ~~The guideline presents monitoring and/or auditing criteria.~~
22. The views of the funding body have not influenced the content of the guideline.
E.g. If developer might have had influence on content of guideline (funding/ company). There should be an explicit statement that the views of interest of the funding body have not influenced the final recommendations (e.g. conflict of interest).
23. Interests of guideline development group members have been recorded and addressed. **Personal conflicts of interest**

OVERALL GUIDELINE ASSESSMENT

For each question, please choose the response which best characterizes the guideline assessed:

- a) Rate the overall quality of this guideline. (strongly disagree 1- strongly agree 10)
- b) I would recommend this guideline for use. (yes, yes with modifications, no)
- c) Notes