Maximizing Children's Opportunities with Inclusive Play: Considerations for Interactive Technology Design

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ABSTRACT
Inclusive play, defined as play among children with and without disabilities, provides learning opportunities that challenge stereotypes, foster strong friendships, and help children develop empathy and other social and emotional skills. Designing technologies to support inclusive play are understudied in Human-Computer Interaction. We synthesized literature, conducted design ethnography in an inclusive classroom, and interviewed and surveyed parents and teachers to explore this problem. Our research contributes an empirical understanding of the current state of inclusive play and a characterization of the design space for interactive technologies that can support children and adults with inclusive play. We identify key facilitators of inclusive play: direct and embedded supports, transparency, adjustability, emphasis on children's interests and strengths, and current technology use. We also describe significant barriers to inclusive play: effort required to facilitate inclusive play, children's preferences, parental inexperience, and inappropriate technology. Through our discussion, we conclude that interactive technologies should be designed to harness the facilitators and help overcome the barriers in order to maximize children's opportunities with inclusive play.

Categories and Subject Descriptors
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Design, Human Factors

Keywords
Inclusion; children; inclusive play; human-centered design; assistive technology; universal design; inclusive design.

1. INTRODUCTION
Inclusion is an approach commonly known within education in which individuals with and without disabilities participate in the same setting. Inclusive programs for children operate based on the theory that engaging children with and without disabilities will positively affect both groups [28]. Children with disabilities benefit from inclusive programs because they are not being implicitly told they are different, wrong, abnormal, or that they do not deserve to have the same experiences as other children. Inclusive environments support all children to develop important social and emotional skills and an appreciation of human diversity [28]. These positive outcomes "ripple through the community of the setting," helping families of children to build inclusive relationships as well [8].

IDC '15, June 21 - 25, 2015, Medford, MA, USA

ACM 978-1-4503-3590-4/15/06···$15.00
DOI: http://dx.doi.org/10.1145/2771839.2771844

For young children, play is a meaningful, active, pleasurable, and intrinsically motivated-experience and medium for learning [8]. Play provides significant learning opportunities that are in line with the goals of inclusion. Through play, young children naturally learn how to communicate, cooperate, make and maintain friendships, control impulses, take different perspectives, and develop other social and emotional skills [16]. Thus, having opportunities for children to play and learn through play is fundamental for inclusion [8]. Play among children with and without disabilities is called *inclusive play* [8].

Despite the theoretical, ethical, and other known benefits of inclusion and inclusive play, there are still barriers to its practice on a broad scale. Generally, the advocacy, training, intentionality, collaboration, and other efforts necessary to enable active, equal participation of all children, often coupled with ableism on macro-, meso-, and micro-levels, prevent children from participating in inclusive environments. Specifically, inclusive education typically requires more support and a greater level of collaboration among teachers and parents [9]. In inclusive settings, supporting play between children of different abilities generally requires more planning and direction than is common in play among children without disabilities. It also requires a greater level of advocacy and education by and for parents or teachers facilitating play. We ask: can critically designed technology help enable and overcome barriers to inclusion and inclusive play in particular?

To answer this question, first we must understand inclusion and where technology could fit into this space. We consider the current facilitators and barriers to inclusive play and define the design space for interactive technology. We particularly focus our efforts on children in preschool and kindergarten since play supports children's social and emotional development during this time [16]. We also concentrated on inclusive play between neurotypical children and children considered neurodiverse, which includes those who experience differences labeled as cognitive, developmental, learning, social, emotional, behavioral, or other similar disabilities [1]. Designing for children with physical disabilities is also important but requires additional, special examination [22].

To understand the current state of inclusive play between neurotypical and neurodiverse children, we employed qualitative methods, including design ethnography, surveys, and interviews using a human-centered design perspective. This enabled us to identify and deeply understand the attitudes, practices, and environmental factors that have implications for technology design. With this research, we aim to connect prior research in early childhood inclusive education and the positive and negative experiences of

teachers, parents, and children to the design of technology. This connection can help us choose where, when, and how to appropriately and thoughtfully design to support children and adults involved in inclusive play.

The main contributions of this paper are an empirical understanding of the current state of inclusive play, including an identification of facilitators and barriers, and the definition of the design space for technologies that can support inclusive play. First, we describe key facilitators of inclusive play: direct and embedded supports, transparency, adjustability, focusing on children's interests and strengths, and positive experiences with technology. Next, we describe significant barriers to inclusive play: the effort required to facilitate inclusive play, children's preferences, parental inexperience, and inappropriate technology. Through our discussion of technology design considerations, we argue the facilitators and barriers are relevant for future technology design. We provide a scenario with a potential design to ground our discussion.

Additionally, this paper adds to the growing movement within the HCI community toward a social model of disability that stems from the disability rights movement and disability studies (e.g., [26]). As we transition from a medical model to a social model of disability, it is important to examine technology as a mediator that may help deconstruct, reconstruct, reeducate, and retool our environment, systems, and society, instead of seeing technology as a tool to "fix" people with disabilities. We hope to inspire future technology design for inclusive play, based on this social perspective informed by inclusive principles, universal design, and the empowerment of all children.

2. BACKGROUND AND RELATED WORK

Designing for people of all abilities is not a new concept. A design approach called *universal design* (also, *inclusive* design) has been commonly applied to many aspects of design, ranging from architecture to interactive technology [25]. The primary goal is to design artifacts that are usable by people of varying abilities. Here we focus on the application of universal design to play-based activities, children, and interactive technology.

2.1 Psychology and Education Research

Researchers in psychology and education continue to work toward creating and identifying effective evidence-based practices to promote social interactions and play among young children in inclusive environments [28][34]. Researchers have tested peer-mediated, naturalistic teaching and preplanning contexts for play dates as interventions to encourage play between young typically developing children and children with autism [10][24]. Researchers have also developed social integration activities and social skills training interventions for young children with disabilities to promote peer interactions in natural environments [7]. Moreover, researchers have examined beliefs of teachers and parents to understand their roles in friendships among children with and without disabilities [3][21]. However, there is little empirical research to help us understand how technology could be utilized in any of these situations. Still, researchers in education and psychology emphasize that technologies are beneficial resources in inclusive classrooms, particularly in fostering genuine relationships [34].

2.2 Play Technology & Neurodiverse Children

Within HCI, there is ample research in designing technology for and with neurodiverse children, especially those with autism spectrum disorders [23]. Regarding empathy, friendship development, and other aspects of social and emotional intelligence and skills, researchers have developed and tested technologies that help neurodiverse children learn through group play. Piper et al. [30] found SIDES, a cooperative tabletop game designed to help adolescents with high-functioning autism practice their group work skills, to be motivational, supportive, and increase social skills confidence. Farr et al. [14] proved the configurable version of a tangible user interface (TUI) called the Augmented Knights Castle resulted in more parallel and collaborative play among children with autism in comparison to the non-configurable version. Farr et al. [15] also proved the TUI Topobo led to more parallel play among children with autism compared to LEGO™, which led to solitary play. These approaches have focused on designing and testing specialized technologies for play among children with a particular diagnosis. In contrast, we are interested in exploring the design space of technologies that support play among children inclusively. In everyday contexts such as classrooms, playgrounds, and homes, universal tools that can bridge the gap between neurodiverse and neurotypical children may be more optimal for inclusion than specialized tools. Nevertheless, the prior successes of technologies tested within these singular populations suggest promise for technologies designed for an inclusive population.

Despite this array of notable work on designing for neurodiverse children, there seems to be less work in designing technology for inclusive play among children with and without disabilities. Holt et al. [22] explored ways to facilitate meaningful play and the development of social and emotional skills for play among children with and without motor impairments in their project *Together through Play*. Our work is similar in its goals. However, at this point, we are not investigating physical disabilities. Additionally, Brederode et al. [6] designed pOwerball, a game for children of mixed abilities to cooperatively fight against a common enemy, which stimulated social interactions. Again, our work is similar in its objective to facilitate group play among children with mixed abilities; however, pOwerball was designed for children ages 8 to 14. Our work aims to build from these technical approaches that promote inclusion, but we focus on a younger population and also consider the wants and needs of the adults who directly impact young children's play experiences.

2.3 Design Space of Inclusive Play Technology

We have reviewed literature in the areas of early childhood education, inclusive and special education, play, and psychology and conceptualized this design space along two unique axes (Figure 1). The first is the *level of inclusion* of the activities. This ranges from *fully specialized,* where the activities are specific to the needs of either neurodiverse or neurotypical children, to *fully inclusive*, where the activities aim to support both neurodiverse and neurotypical children. The second dimension is the *type of play*, which ranges from *structured*, where play is goal-oriented with rules and pre-determined organization, to *unstructured*, where play is open-ended, imaginative, and lacks goals or rules.[1] Each of these dimensions is a spectrum, meaning there is space in the middle for semi-structured play and increased or decreased levels of specialization, depending on the wants, needs, and values of the child and the family. In addition, there are benefits to being on all areas of the map.

The definition of this space allows us to identify existing strategies and opportunities for future work. In our review, we found that most technologies have focused on the left quadrants of the map, as we did not find research focusing on the top-right quadrant and found limited work in the bottom-right. Most technologies in re-

[1] http://parenthood.com/article/the_importance_of_play.html

search have focused on supporting children with only a certain type of disability (i.e., *fully specialized*). Our map of this design space (Figure 1) has helped us identify an underexplored area, highlighted in blue, in designing to support unstructured and structured play among young neurodiverse and neurotypical children.

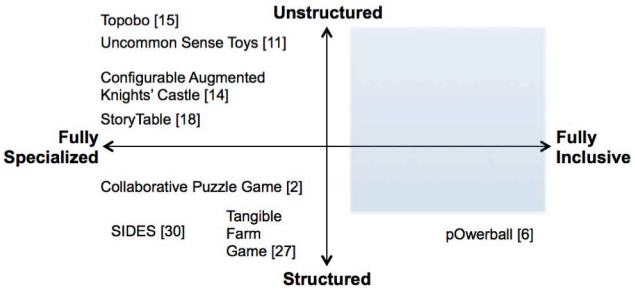

Figure 1. Map of the technology design space for play among children with varying abilities. Shaded area is underexplored.

3. METHODS

We took an exploratory, qualitative approach to examining the current state of inclusive play broadly and the role of technology specifically. This involved studying children directly as well as the teachers and parents who directly impact young children's inclusive play experiences. We primarily studied children through design ethnography and running our own design activities in an inclusive classroom aimed at gaining insight into their perspectives, wants, and needs. To supplement our observations, we conducted surveys and semi-structured interviews that gave us access to additional perspectives of teachers and parents. We felt these methods would complement our classroom observations and involve additional stakeholders. Taking into account the experiences, needs, and attitudes of these adults was important in this context because they directly influence children's development, relationships, and experiences. Table 1 provides a table of our participants. Below we describe each of our methods and our data analysis.

Table 1. Connection between participants & methods. *Inclusive play required +Inclusive play not required

Participants	Participant ID	Method
Neurodiverse children from inclusive classroom	*CND1 - CND3*	Workshops 1 & 2
	CND4 - CND5	Workshop 3
Neurotypical children from inclusive classroom	*CNT1 - CND3*	Workshops 1 & 2
	CNT4 - CNT5	Workshop 3
Inclusive classroom teachers	*T1 - T4*	Survey
	T5	Interview
Parents of neurodiverse children	*PND1 - PND14*	Survey 1*
	PND15 - PND22	Interview*
	PND23 - PND24	Survey 2+
Parents of neurotypical children	*PNT1 - PNT2*	Survey 1*
	PNT3 - PNT4	Interview*
	PNT5 - PNT27	Survey 2+

3.1 Inclusive Classroom Design Ethnography

The design ethnography involved the lead researcher volunteering weekly in two joint inclusive kindergarten classrooms that were each nearly evenly split between children with and without diagnosed disabilities. There were 18 children in one classroom and 17 in the other, but the classrooms were often combined for learning and play activities. The lead researcher volunteered as a teachers' assistant, helping in the classroom for approximately 70 hours over eight months. She collected data by taking notes during and/or after classroom sessions. The lead researcher also completed a graduate level course in Early Childhood Special Education, which provided information on theory-based and evidence-based practices in the field, which informed her volunteer work.

The kindergarten classes are part of a well-resourced inclusive school and research center with high teacher-to-student ratios, well-qualified and supportive staff, interdisciplinary teams, and a clear focus on promoting high quality learning for children of all abilities. The school also provides support programs for parents and caregivers, so families are also engaged in their children's education. This classroom served as an archetype for high quality inclusive education that encourages social and emotional learning.

To supplement our observations in the classrooms, we also ran three design activities at the school with mixed groups of children, lasting between 30 to 45 minutes each. During these workshops, we discussed the children's favorite types of toys and play activities. The children also crafted their own toys to promote cooperative play (see Figure 2). These sessions allowed us to (1) gain more hands-on experience and detailed personal interactions with the students and (2) to understand the types of activities in which children could and wanted to engage together. Each session involved 4 to 6 children, half of whom were neurodiverse. We video recorded the activities and took notes during and after them.

Figure 2. Children building aliens and spaceships together during the second design workshop.

3.2 Teacher Surveys and Interview

Although we were able to observe teachers in the classroom, it was often difficult to obtain their perspectives and ask questions while they were directly working with children. Thus, to obtain a more robust understanding of educators' experiences with inclusion and with technology specifically, we recruited teachers from the aforementioned school to participate in interviews or surveys in order to be respectful of their busy schedules. We interviewed one kindergarten teacher in-person, and four other kindergarten and preschool teachers answered the interview questions in a survey format. The questions we asked included open-ended questions on their opinions on inclusion, play, technology, and strategies for encouraging play and other social interactions. We kept the definition of technology open-ended but included a list of ex-

amples of technology (e.g., game systems, interactive toys, tablets, mobile phones, wearables, cameras, computers, projectors, etc.) as to not limit our understanding of technologies in this context. However, teachers spoke mostly about the iPad, since it was frequently used in their classrooms.

3.3 Surveys and Interviews of Parents

One of our goals is to take the successes of an inclusive classroom and make them more broadly accessible outside the school setting. Because of this, and because parents directly impact their children's development, relationships, and experiences, we investigated parents' perspectives on inclusive play and where they believed technology could be the most effective tools to help them, their own children, other children, and other parents with inclusive play. Again, we kept the definition of technology open-ended but included a list of examples. We deliberately did not recruit parents from the aforementioned inclusive school; rather, we sought more heterogeneous perspectives, especially of parents who are not supported by a state-of-the-art inclusive school. We recruited alternative perspectives via parent mailing lists, Facebook, organizations for children with disabilities, and Amazon Mechanical Turk to participate in open-ended surveys or semi-structured interviews.

We first recruited parent participants with the requirement that their children must have previously engaged in inclusive play with a child with a disability at least once. We conducted an open-ended survey (Table 1: Survey 1) with 16 parents whose children were between the ages of 3 and 12 and had participated in inclusive play dates. Only two of the sixteen had neurotypical children. To gain additional depth, we also conducted 10 semi-structured interviews (Table 1: Interview) with parents, four of whom had neurotypical children. Finally, to get additional perspectives from parents of neurotypical children to balance our data from parents of neurodiverse children, we conducted an open-ended survey (Table 1: Survey 2) with 25 parents that did not require the participants' children to have participated in inclusive play. This resulted in a higher response rate of 23 parents with neurotypical children. We asked these parents additional questions concerning whether they would like their children to have more experiences with neurodiverse children. We recruited parents with children ages 3 to 12 because we could learn from parents who had desires for and reflections on the future, current, and past experiences of their own children that would be relevant to children ages 4 to 6.

3.4 Data Analysis

We analyzed our survey, interview, observation, and design workshop data using an iterative approach to qualitative coding, both inductively and deductively, to uncover consistent themes across different stakeholders and contexts. Initially, we coded our data inductively to identify emerging themes. As we reached data saturation and themes began to stabilize, we adopted a deductive coding approach. These themes represent the current state of inclusive play and technology's place within it. We report the thematic ways in which inclusive play works well and where barriers to inclusive play remain.

4. INCLUSIVE PLAY: CURRENT STATE

Here we describe facilitators and barriers to inclusive play based on our literature review and our study results. Rather than organizing our results by method, we report based on themes that can help inform technology design. This is reflective of the fact that themes regarding facilitators and barriers of inclusive play span across experiences among children, teachers, and parents.

4.1 Facilitators of Inclusive Play

At the foundation of a successful inclusive setting, or any childhood setting, is a safe, comfortable environment [32]. Both teachers and parents commented on the importance of a safe environment in helping their children thrive. Beyond this foundation, there are a number of things that work well currently to facilitate inclusive play. Below we go over these facilitators to inclusive play. The categories are not mutually exclusive. In fact, most draw on each other and incorporate aspects of multiple other categories. Additionally, many of these facilitators extend to enabling non-inclusive play; however, we emphasize that play among neurotypical children may not *need* these facilitators to occur, whereas they are central to inclusive play. In the discussion, we will expand on how these facilitators can help guide the design of technology for inclusive play.

4.1.1 Direct Support and Embedded Support

To assist children in inclusive play, adults provided a mix of direct and embedded support. Within early childhood inclusive education, there are teaching strategies and curriculum modifications regarding different types of supports, like adult support, peer support, invisible support, and embedded learning opportunities [32]. Here we discuss the ways in which we observed teachers using direct and embedded supports and the ways in which teachers and parents described these supports to facilitate inclusive play.

Direct Supports: Adults provided explicit support for play interactions among children by teaching social and emotional skills concepts directly. They also provided physical and language tools for children to use during play. The goal is for the children to generalize these skills and concepts to natural settings. In the classroom, teachers gave lessons on friendship, how one's own actions can affect other people, what particular emotions (e.g., worried) look like and feel like, what people can do in response to different feelings, and how all people are both similar and different. They taught children specific language to use during playtime, such as "a bug and a wish." This language helps children be clear by saying, "It bugs me when…" and "I wish you would…" Teachers also taught children specific language to use during play to make sure they are being good friends to each other. For example, children "fill their buddy's bucket" when they are acting kind or "dip into their buddy's bucket" when they are not kind. This language, which comes from the children's book *Have You Filled a Bucket Today?* by Carol McCloud, allowed the children to see from others' perspectives and to understand that their actions or words can affect others.

We also observed physical tools used in the classroom such as play plans, social stories, and a Friendship Kit. Play plans are lists of play activities children create together to ensure each child gets to do her preferred play activities. Social stories are short scripts for children to follow to learn play skills, such as inviting other children to play or compromising when they do not get their way [20]. The Friendship Kit is a physical tool that holds bandages, sticky notes, pencils, stickers, and play scripts that children can use to be good friends. Children used the Friendship Kit when they wanted to make another child feel happy or learn how to play with another friend.

Parents of neurodiverse children also reported directly supporting their children to promote inclusive play. They do this by teaching other parents and other children about their child's disability. They also teach parents what makes their child the same as and different from other children. One parent of a neurodiverse child (*PND15)* felt that one of best ways to help neurotypical children play with

children with disabilities is to *"offer a safe environment where they are given info about what to expect and how to handle a situation, should it arise."* Giving direct information to children about how to play with other children is effective in facilitating the play.

Embedded Supports: Adults also provide implicit support for play interactions by embedding learning and play skills within activities. These embedded supports help children in context and in real time without teaching concepts directly. We observed teachers providing embedded support by assigning buddy pairs based on similar preferred activities, prompting interactions between children (e.g., "Tell your buddy what you are building.") and giving positive feedback to children to reinforce pro-social behavior.

In line with literature on play and learning play skills [16], teachers commented on how particular toys, games, and other types of play have embedded supports in them. They explained these supports promote active engagement among children, encourage social interactions, and teach play skills implicitly (e.g., board games require children to take turns; children cannot use a wagon alone). Teachers intentionally provided these objects in the class.

Some parents commented on the types of inclusive play activities they want their children to do that have embedded supports. One parent (*PND2*) mentioned that during inclusive play, children should only participate in activities that encourage interaction and avoid those that are mostly done by one person. Another (*PND16*) said her neurodiverse child and neurotypical friend "*take turns going down the slide and will ride the teeter totter together*." The slide, which seems like an individual play structure, can become an embedded learning experience for children to practice taking turns. And, like a wagon, a teeter-totter cannot be used alone.

Another parent of a neurodiverse child (*PND12*) brought up the importance of having inclusive play dates involve activities where children have opportunities to succeed and to demonstrate their strengths: "*They can participate in activities where they excel and have a chance to demonstrate their knowledge or lead other kids. They can learn new skills with other kids."* By arranging play activities that allow children to demonstrate their existing skills and learn new ones, parents are embedding supports within the play date.

In our workshops with the children, we witnessed embedded learning during the design activities. They built off each other's ideas. For example, in Workshop 2, when one child started making a "stuffie," other children started to do the same thing. Building also led to children working together. For instance, in Workshop 3, one child (*CNT4*) wanted to put tape around a group of straws, but he needed both hands to hold them together. Then, another child in the group (*CND5*) offered to put the tape around the straws while the first child (*CNT4*) held them together. This is an example of how even open-ended art activities give children opportunities to cooperate. There are formalized methods for embedding cooperation into art too, such as providing fewer supplies than are needed so children take turns and share [32].

4.1.2 Transparency

Another theme that emerged from our data was how vital transparency among children and adults is to inclusive play. For children, this means explaining the role of the environment, attitudes, and impairments in children's experiences of disability. For adults, this means explaining to the parent of the neurotypical child who the neurodiverse child is, what the child's needs are, and that both children have important roles in facilitating inclusive play.

A teacher interviewee (*T2*) noted that being open and honest with children has been an effective way to encourage social interactions between children with and without disabilities: *"One thing that I think has really helped with encouraging social interactions, especially for children who may have challenging behaviors ([e.g.,] tantrums, hitting, biting, etc.) that may make it harder for other kids to want to play with them, we tell the typically developing children honestly that 'Student 1 is still learning how to keep their body safe. We are all working on different things. You might be working on learning your letters… You can help remind them by telling them to have a safe body.'"*

This example highlights how transparency can build empathy. By explaining to neurotypical children explicitly about their neurodiverse peers, they know what to expect and understand that *everyone* has different things to work on. This leads to more understanding and social interactions among children.

Survey and interview participants who were parents of neurodiverse children agreed that transparency is important among children and parents. One parent (*PND16*) mentioned in terms of being open with children, *"Kids often think my daughter is younger so rather than letting them treat her like a baby, I like to tell them about her strengths and also areas where she might be different. I think they are more likely to include her if they understand how she is different and also how she is the same."* This parent felt that giving neurotypical children opportunities to better understand her daughter increases the likeliness that her peers will include her.

Regarding transparency with other adults, another parent (*PND9*) said, *"I think we can do so much to open up a dialogue between parents that can make everyone feel comfortable. I always tell parents that it is pretty much impossible to offend me so please, please, please ask me anything that they want to about [my child]. I guarantee I've heard every weird question that there is. I love making other people comfortable around him."* Being open and transparent with other parents allows everyone to feel more comfortable and prepared for inclusive play.

4.1.3 Adjustability

As witnessed in the literature and during classroom observations, an important aspect of inclusive play is adjustability, meaning activities or objects must be adjustable to the needs of all children. This is in line with Universal Design for Learning (UDL), an educational framework for developing flexible environments that allow for equal access to learning, based on universal design [31]. UDL maximizes opportunities for all children because there are multiple means of representation, action, expression, and engagement for activities, tools, and other relevant objects and experiences. By adjusting play experiences to meet the needs of all children through different means, all children are able to partake in them.

While parents of neurodiverse children did not mention adjustability as part of inclusive play, adjustability is a key component of the inclusive classroom, specifically because of how UDL is a part of the Individuals with Disabilities Education Act,[2] a federal law in the United States that ensures children are provided with appropriate services by their states and education agencies. In the classroom, teachers were constantly modifying, individualizing, and adapting in the classroom, including play spaces, activities, and objects, to meet the needs of the students. Teachers customized each experience based on the children involved in order to accommodate all of them. For play activities, this sometimes meant

[2] http://idea.ed.gov

providing extra support with adult scaffolding. They also often incorporated child preferences into play activities, like involving two children's favorite animated characters into pretend play to make it possible for both children to be invested. The adjustability of inclusive play activities and objects ensures more opportunities for successful play among the children because their experiences are individualized, customized, and motivated. These adjusted experiences take into account children's abilities and needs [32].

4.1.4 Focusing on Children's Interests and Strengths

Within early childhood inclusive education, one type of curriculum modification is the use of child preferences in classroom activities [32]. Similarly, mutually reinforcing activities in play dates promote quality interactions and encourage the development of friendships between children with and without autism [12]. For inclusive play activities, we observed teachers making these experiences about the children as much as possible. When two children were paired as buddies for a play activity, the teachers announced the children's commonalities (e.g., *both children love baseball!*), and the children were always excited. Although the children may be different in some ways, focusing on what the children had in common gave them something over which to bond and on which to focus their experiences.

One teacher (*T5*) explained the importance of giving the children options about preferred play activities to encourage social interactions during inclusive play. By offering choices to the children—like playing one buddy's preferred game first and then after some time, switching to the other buddy's preferred game—*"gives them that incentive to stay and play."*

Parents commented on the value of focusing on shared interests among children and celebrating their strengths too. Some noted how children rely on common interests and preferred activities during inclusive play, as those shared experiences bring them together in the play date. In relation to what children should do during inclusive play, a parent of a neurotypical child (*PNT24*) said, *"I think anything that builds upon a child's strengths should be highlighted and encouraged."* While incorporating children's interests and strengths is important in play among solely neurotypical children as well, this is particularly important for children of differing abilities to find common ground and celebrate each other and themselves.

In line with stages of humor development [33], in the classroom and during our workshops, most children had similar senses of humor. This was true regardless of disability. Unexpected behaviors and actions, toilet humor, and other silliness made the children laugh. During the design workshops, all of the children thought making fart noises with balloons was hilarious, and they were hysterical when one child during Workshop 1 (*CND1*) kept turning off and on the lights in the room. Humor was common ground for the children.

4.1.5 Technology as a Tool for Inclusive Play

We found that teachers, parents, and children all used technology as a tool to facilitate inclusive play. Teachers used technology to support play and social interactions. They used individual iPad time as reinforcements for positive behaviors. Children also used technology in the classroom in innovative, collaborative ways for which the technology was not originally intended but were meaningful to them. For example, during free play in the classroom, one child dictated to another child what to type on the keyboard of a desktop computer; they switched off who typed and who dictated, so turn-taking was embedded in this activity. Children watched each other play games on the iPad during free choice too. To play a baking game, they passed the iPad around so they could each add cookie ingredients. Again, turn-taking and sharing were embedded in this interaction.

When parents reflected on what was most important to them in terms of using technology for inclusive play, they commonly referred to the potential of technology to provide more opportunities for different aspects of inclusive play. They believed technology could provide children more ways to overcome communication barriers and more opportunities for parents to learn more about their children's friendships. Communication is often difficult for children in general, but in inclusive play situations, there may be more barriers to communication than in play with only neurotypical children. One parent (*PND25*) noted, *"Using technology will help those children find their voices and be able to really participate."* Another parent (*PNT24*) commented, "*Being able to reach out to another child who needs support or friendship via any mode of communication [like technology] can only be positive*."

Similarly, some parents viewed technology as a tool that would allow them to find out more about friendships and inclusive play moments. A parent of a neurodiverse child (*PND19*) believed parents should use technology to share great inclusive play moments. She said, "*I love seeing photos of my child playing with typically developing peers*." Likewise, another (*PND28*) said, "*I would be interested in learning more about friendships during the day at school [using technology]."* In these cases, parents believed technology could help them to discover more about their children's friendships, so they could feel at ease about their children and more easily set up play dates.

During an interview, one parent (*PND33*) said she would record her child during speech therapy and show the videos to her child's playmates. Using technology as a communication tool allowed her to be transparent and open with other children without the need for them to attend therapy sessions.

Some parents also noted how their children played video games during inclusive play dates. One parent (*PND28*) talked about how some Wii games her neurodiverse son and his friends play are collaborative: *"I know they were talking about how to hold the controller... So it's more of like how to help each other do better at it... 'Oh, if you step this way– here try this. No, let me try that.' Or they're laughing because you can create your characters on the Wii… They just make the most ridiculous characters possible, [like] Marty Fartcowski, the pitcher."* This parent appreciated how her son and his neurotypical peers had social interactions in the non-digital world when using technology. The game also allowed them to find common ground in their silly senses of humor.

4.2 Barriers to Inclusive Play

Next, we describe the barriers to inclusive play that we identified in our study. These are mostly tensions between what is required to facilitate play and what adults and children are actually able to do. Here, parallel to our description of how technology was helpful for inclusive play, we also report on perceptions of technology as an inappropriate tool to enable inclusive play. Later, we describe what implications these barriers have on the future design of technology in this space.

4.2.1 Effort Required to Facilitate Inclusive Play

In the early childhood education literature [12] and as evidence in our data, creating a meaningful inclusive experience for young children requires a great amount of intentionality and effort by adults. In the classroom, providing high quality inclusion programs takes more than merely placing children of differing abili-

ties in the same classroom. Among other things, it requires developing an appropriate curriculum that can be accessed by everyone, individualization, and adaptations [9]. This requires teachers to know each student, his or her wants and needs, and the adjustments that are necessary to accommodate and attend to those wants and needs. Unfortunately, general education teachers often do not get enough support or do not feel prepared to teach children with special needs [17]. This lack of support creates barriers to inclusion and, therefore, inclusive play in these settings.

In home settings, we found that parents have to make great efforts to set up and monitor play dates among their neurodiverse and neurotypical children. Parents of neurodiverse children described the extremes they went to in order to support their children's friendships or support their children during play dates. Many of these efforts were directed at tackling the stigma and isolation experienced by children with disabilities. For example, one parent (*PND9*) described how she tries to be open and available to other parents and let them know about how their children are friends with hers so it is easier to set up play dates: *"I do a presentation at the beginning of the school year in [my child's] classroom. I send home a letter letting them know what we discussed with their kids that day and my contact info. I also attend the classroom get-togethers like parent night and try to remember which kids belong with which parents. Then I listen closely when [my child] talks about his friends from school so the next time I see their parents I can tell them that [my child] enjoys spending time with their child and what things they have done together that [my child] has told me about… I also ask his teachers to let me know if there are any great moments between [my child] and his classmates."*

Another parent of a neurodiverse child (*PND16*) described taking similar steps: *"When my daughter starts school every year, I send a letter to the school staff about my daughter and how she interacts with other kids. I also send a letter home to the parents so they know that there is a child with Down syndrome in their child's class. This allows them to discuss it with their child."*

However, parents also noted their busy schedules and hectic days. Not all parents have the time, energy, or resources to go to these great lengths. For instance, one parent (*PND28*) described an experience in which she was thankful when a family was honest about why they had not called to set up more play dates with her son. Although this parent said she was happy that finally another parent was honest with her and that the response was something she can *"work with,"* the incident manifests the barrier to inclusive play: *"… one parent said, 'I find when you ask for a play date with [your son] that I have to really make sure that I'm prepared for it.' I'm like, 'Oh, what do you mean?' She's like, 'He has so much energy and he just needs to be busy.' She said, 'I just need to be in the right frame of mind to take him on.' She said, 'I love when I have him here. But if I'm having a tired day, that's not going to happen.'"* The fact that the parent of the neurotypical peer had to change her frame of mind for this participant's son to come over acted as a barrier to them playing together.

4.2.2 Children's Preferences

While we described how focusing on children's interests and strengths can help teachers or parents facilitate interactions between children, children's preferences can also interfere with inclusive play when they are not given the support they need. We observed that children who are not offered appropriate support end up playing in parallel when they are developmentally ready to engage in collaborative play. This is a missed opportunity for developing crucial social and emotional skills through play. Similarly, a parent of a neurodiverse child (*PND2*) noted how sometimes it looks like her son is playing with other children but really is not interacting with them: *"Overall it seems like he plays in a big group of children. But when observed over a period of time, you will see that there is no actual interaction between him and his peers. He looks at other children sometimes but wouldn't want to join in…. Although other children try to interact with him, he tends to ignore or refuse them."*

During our design workshop sessions, we often ran into the issue of children not wanting to play together because playing alone seemed to be their inherent preference. When one neurodiverse child in Workshop 1 (*CND4*) was making an alien by himself and one neurotypical child (*CNT5*) was making something else by himself, we suggested they combine projects. The first child (*CND4*) was insistent that his alien head did not need a body and that he would not join his project with the other child's *(CNT5*).

Other parents of both neurotypical and neurodiverse children commented on how they believe that children's perceptions of playmates can be barriers to inclusive play because they are drawn to kids who are similar to them and stay away from those who seem different. Some parents explained how a lack of understanding of differences might be more at the root of a child's preference to not play with other children. One parent (*PND16) said, "Generally, I believe kids want to play with other kids. If they try one thing to engage another child and it doesn't work, they will usually try something else. I think they look for parents, though, if they can't understand the differences in another child. If it is too hard to understand, they will likely go play with someone else."*

Additionally, during the workshops, although some of the most meaningful experiences occurred when the children built together, this often occurred when each child had a clear stake in the end goal, which brought attention to him or her as an individual. For instance, when one child (*CNT2*) was building a spaceship for aliens, another child (*CND1*) added a rope onto the spaceship for *his* alien. Moreover, when a child (*CND5*) was building a robot and another child (*CNT4*) helped, the first child (*CND5*) always referred to the robot as *hers* and never *theirs*. It was important to most of the children to be able to bring their creations home too. In these instances, the children were working together but not pushing past their own individual preferences. While being egocentric is developmentally appropriate from age 2 to 7 [29], this can be a challenge for children to engage in inclusive play.

***4.2.3** Unfamiliar Territory for Parents*

Some parents of neurodiverse children had negative views of other parents, commenting on how they believed other parents of neurotypical kids were the biggest barriers to inclusive play. A common perception was that parents of neurotypical children were uninformed about disabilities and the needs of children with disabilities. One parent (*PND9*) stated parents' "*fear of the unknown*" is a barrier, while another (*PND6*) was blunter: *"[The biggest barrier is] parents who don't value it. They aren't willing to push past their own personal discomfort/misunderstanding/preconceived notions about a particular diagnosis to allow their children to have new experiences. They may assume that there are medical or behavior issues that don't exist and therefore don't include my daughter in play dates or party invitations."*

However, all 23 parents of neurotypical children we surveyed reported advantages of having their children play with neurodiverse children, such as learning acceptance and an appreciation of human diversity, which is a main goal of inclusion [32]. Eighteen of the 23 parents of neurotypical children answered that they

would be interested in having their child play with more neurodiverse children if given the opportunity. Unfortunately, 15 of these 18 parents reported that their children have not previously had any opportunities to play with neurodiverse children. They described a lack of neurodiverse acquaintances, with no such children in their child's classes, at their school, or in their neighborhood. Addressing the perceived lack of opportunity to engage with neurodiverse children is an important design opportunity in the inclusive play design space.

Finally, there were a couple reasons the remaining five parents were not interested in having their children play with more neurodiverse children if given the opportunity: either they let their children choose their own playmates or their children already have some experience playing with neurodiverse children. One of these parents (*PNT34*), who said her children play with children with autism and ADHD, was not interested in having her child play with more neurodiverse children because it is unfamiliar territory. She was the only survey participant to explicitly mention a lack of understanding of disabilities: *"I don't have full knowledge…I wouldn't know how to react or interfere if need be."*

When parents of neurotypical children described possible disadvantages of inclusive play, some disclosed how they were concerned their children might not understand the other children and this might cause frustration, anxiety, confusion, or fear. The majority believed there were no disadvantages. Only one parent of a neurotypical child (*PNT48*) harbored a negative view that playing with neurodiverse children might "*diminish [her daughter's] desire to learn as much as she can*" and so "*she may regress in terms of her learning.*" These fears reflect ableist beliefs and misperceptions that can be significant barriers to inclusive play and to people with disabilities in general.

4.2.4 Concerns about Technology for Inclusive Play

Teachers and parents harbored attitudes toward technology that interfered with their willingness to adopt technology for inclusive play. Parents and teachers perceived technology use as an independent and/or passive activity for children. Although all teacher participants used the iPad as a reinforcement tool in their classrooms, two teachers mentioned issues they had with the technology for their students. One teacher (*T1*) said, *"I like how much [the iPad] motivates the children to help them be their best [selves]. I don't like that its main emphasis is on solitary play and not on social interactions or cooperative play."* This statement is consistent with our observations of some children playing with the iPad or on the computer in the classroom purely independently.

The majority of parents of neurodiverse children reported that they did not use technology during inclusive play. Many noted that they did not find technology to be interactive between children. One parent (*PND21*) said she believed that instead of using technology, "*children should be doing activities that give [them] an opportunity to socialize together.*" As opposed to seeing technology as a tool that could embed supports for interactions, parents did not believe technology could help children practice their play or social skills and thought that children might become too reliant on technology as a tool.

Some parents of neurodiverse children also had issues with technology as a crutch that does not enable, augment, or scaffold interactions in the real world. For example, a parent (*PND28*) said using technology during play dates was not always a good idea for her son because it is "*a little too easy to stay in your own head,"* and *"he [needs] to step out of his head and get out there and have a direct interaction."* Another parent (*PNT26*) corroborated this view, as she believed that technology did not support true interactions: *"Other than breaking the ice, I feel like it prevents the kids from really playing together… They're interacting with the technology. They might be collocated but they're not actually interacting with each other."*

5. DESIGNING TECHNOLOGY FOR INCLUSIVE PLAY

In moving forward to maximize the opportunities for children to participate in inclusive play, there are a number of considerations for designing technology that we can derive from our results. See Table 2 for a summary of these results. The facilitators and barriers to inclusive play present opportunities for children, teachers, and parents to use technology to make meaning in their individual and joined experiences. Here we discuss how technology may help facilitate and overcome barriers to inclusive play by providing current technology examples. Lastly, we ground our discussion in a scenario with a fictitious technology example that accounts for all of the facilitators and barriers.

Table 2. Summary of inclusive play (a) facilitators (top) and (b) barriers (bottom).

Facilitator	Example
Direct support	"It bugs me when… I wish you would…" language
Embedded support	Sharing art supplies
Transparency	Explaining how all children are similar and different in various ways
Adjustability	Adults scaffold each child's play interactions as needed
Focus on child interests & strengths	Toilet humor is funny for children, regardless of disability
Technology as a tool	Children take turns on keyboard

Barrier	Example
Effort required	Planning, intentionality, and attention needed for inclusive play
Children's preferences	Children misunderstand differences in others and avoid these people
Unfamiliar territory for parents	Parents do not have experience with children with disabilities
Technology concerns	Technology can be solitary

5.1 Design Considerations

The facilitators and barriers we have identified can be used to examine the gaps and affordances of current technologies to maximize children's opportunities with inclusive play. For example, more games like SIDES [30] could be designed to decrease the *effort required to facilitate inclusive play* by enforcing rules within gameplay to encourage cooperation *implicitly*. Sesame Street programming and interactive media [19], which incorporate characters with disabilities (*implicit teaching*) and teach about disabilities *explicitly,* can inspire technology designs that promote *transparency*, open communication, and reflections on biases. Other technologies like the Augmented Knights Castle, which incorporates children's voices into the toy [14], offer examples of how to

make play in this context *adjustable*. Adjustable technologies also offer new ways for children to experience *shared interests* and show each other their *strengths* based on how and what they create with the tool. By using the theoretical lens developed in this paper, designers can identify affordances of current technologies that can be replicated and generalized to future technologies to maximize opportunities for inclusive play.

The facilitators and barriers we identified can also be used to understand what *not* to design. For example, the areas in which adults are *concerned about technology* for children suggest that technologies should be designed to scaffold children's interactions, rather than act as a crutch that inhibits interpersonal growth. A positive example of this type of scaffolding is CamQuest [5], a simple pedagogical tool that enables preschool children to recognize and explore geometric shapes by taking pictures of objects in their environment. There is no automatic recognition or feedback from the system, which enables children and adults to discuss why the objects in the pictures fit or do not fit in the shape, fostering real-world interactions and discussion.

More work is needed to investigate how our design insights might apply differently to unique contexts (e.g., home vs. school) and how ethics might play a role in the design of technology for inclusive play as well. While our work points to stakeholders' values surrounding technology and play, future work can explore how values like privacy might introduce tradeoffs between facilitators and barriers when designing inclusive play technology.

Finally, there has also been movement toward not only designing *for* neurodiverse children but also with them (e.g., [4], [13]). Designing with neurodiverse children has goals akin to those of inclusion. By trying to understand the needs of children with different abilities, we can apply their strengths to see how to support them in the design process while also empowering them. Participatory design in this space usually involves children who are older than six because designing with younger children is not usually recommended [13]. However, based on our experiences with children in the classroom, there is room for innovation on new methods that can support designing with children of mixed abilities.

5.2 Example Technology Scenario

We imagine an interactive technology that incorporates all of the facilitators, overcomes barriers, and takes other technology considerations into account. Here we describe a simplified scenario in which parents and children use this technology.

Consider Alex, parent of five-year-old Morgan who is neurodiverse. Alex wants to help Morgan develop social and emotional skills and strengthen friendships. Jordan is a neurotypical child in Morgan's kindergarten class. Jordan's parent is Taylor. Parents Alex and Taylor meet when picking up their children from school and plan a play date for their children.

During the play date, Morgan and Jordan play an interactive adventure game on the iPad that augments interactions with the natural environment. To help them make their way through the adventure game, the iPad prompts the children to ask each other questions (e.g., "To unlock the door, ask your adventure partner what his or her favorite food is and draw a picture of it together on the screen). In other instances, the iPad prompts the children to take pictures or videos of each other (e.g., "Take a picture together where you are both making your silliest faces." "Record each other making your loudest fart noises," or more seriously, "Record your partner telling you what you should do to make him or her feel better when he or she is sad."). By completing the tasks outside of the digital environment, almost like a recordable activity book, the children complete the game together. Parents Alex and Taylor can both review the game remotely to look at the pictures, videos, and other logs of the children's game progress.

This interactive technology offers Morgan and Jordan *direct support* by prompting interactions that relate to social and emotional learning or by explicitly teaching these topics. It provides *implicit support* by embedding turn-taking and cooperation within the game setting. There is a focus on *transparency* for both of the children and their parents. Through direct supports, Morgan and Jordan can learn that all children are similar and different, and they learn about their own similarities and differences. With the option to review their children's play, the parents can learn more about the friendship and how to support their child's friend. This remote viewing can help facilitate conversation beyond the technology for the parents as well. The game is *adjustable* because Morgan and Jordan choose what to record based on their own preferences and abilities. It also highlights the children's *strengths and interests* because gameplay with Morgan and Jordan is different than it would be with other pairs of children. They have the chance to customize their play to fit their wants and needs because the content of the recordings or drawings are based on the specific children's gameplay.

This technology would ideally lower the *efforts required* to set up and monitor inclusive play dates due to how parents Alex and Taylor can use the game to better understand their children and communicate within and beyond the technology. This would also help educate Taylor to address any *inexperience* Taylor has with children like Morgan. Because Morgan and Jordan get to record themselves, talk about themselves, and show each other their strengths, any *preferences toward individuality* in play could be preserved without getting in the way of them playing together. A focus on interactivity beyond the digital environment addresses *concerns with technology* regarding solitary play with technology.

Play with this interactive technology is semi-structured, as it involves a more structured game that can be completed through more imaginative, unstructured tasks. The game is also fully inclusive. Therefore, the hypothetical design falls in the underexplored, shaded area in Figure 1. Overall, this scenario is an example of how future interactive technology design might build on our work to maximize children's opportunities with inclusive play.

6. Conclusion

Providing more opportunities for inclusive play promises to improve experiences for neurodiverse children and build the empathy of everyone involved. We argue for ways in which interactive technology can be designed to provide empowering, supportive opportunities for adults and children to engage in inclusive play.

In this paper, we created a map of the design space for inclusive play, revealing an underexplored research area in technology for play among children who are neurotypical and neurodiverse. We then examined inclusive education as an archetype for high quality inclusive practices, worked with and observed children, and elicited adults' opinions on inclusive play and technology. From this, we generated a thematic description of the current state of inclusive play that the IDC and HCI community can use to shift their perspectives on how to design for and with children with disabilities and their peers. We hope to inspire new avenues for research innovation in this area.

Our work adds to the growing movement toward a social model of disability in which we consider technology, not as a tool to change people with disabilities, but as a tool to help change our environment, systems, and society and support individuals inclusively.

7. ACKNOWLEDGMENTS

We would like to thank all of our participants and Daniela Rosner and Alexis Hiniker for their feedback on the paper. We also thank the UW Disability Studies Program for providing funding with the Harlan Hahn scholarship. This material is based upon work supported by the National Science Foundation Graduate Research Fellowship under Grant No. DGE-1256082. Any opinion, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the NSF. This research was reviewed and approved by the University of Washington's Institutional Review Board.

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