Intentional Technology Use in Early Childhood Education

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Early childhood is a critical developmental period when children's experiences have lasting impacts on long-term outcomes. Thus, an evidence-based understanding of how technology can support early childhood education (ECE) classrooms promises to be disproportionately useful to children's long-term wellbeing. We conducted an observational study at ten child-care centers, complemented by interviews with teachers and directors. Using a *Uses and Gratifications* (U&G) perspective, we found that the gratifications teachers seek when they incorporate technology into the classroom cluster into six categories, such as encouraging technology literacy, regulating children's behavior, and supporting child autonomy. Using these themes, we contribute a set of design priorities for supporting this population. We also contribute an expansion of the U&G perspective to include: 1) *gratifications resisted*, to account for the ways in which teachers resist gratifying uses of technology, and 2) differentiation between *direct gratifications* and *indirect gratifications* to better describe technology use in collaborative contexts.

CCS Concepts: • **Human-centered computing → Empirical studies in HCI**; *Empirical studies in interaction design*; • **Applied computing → Education**.

Additional Key Words and Phrases: Early Childhood Education; Preschool; Child Care; Uses and Gratifications Theory; Design

ACM Reference Format:
Ishita Chordia, Jason Yip, and Alexis Hiniker. 2019. Intentional Technology Use in Early Childhood Education. *Proc. ACM Hum.-Comput. Interact.* 3, CSCW, Article 78 (November 2019), 22 pages. https://doi.org/10.1145/3359180

1 INTRODUCTION

Early childhood is a time of rapid and critical development, and the experiences that children have in their first years of life have a disproportionate influence on their long-term outcomes [13, 79]. As a result, scholars, policy makers, and educators in many countries have invested heavily in developing and evaluating early childhood education (ECE) programs [6, 82, 83, 91]. A large body of prior work shows that, holding other factors constant, high-quality ECE experiences increase children's cognitive and non-cognitive competencies later in life and have moderate to strong effect sizes [58]. As a result, there is support across academic fields related to child development for continued work to design and refine effective ECE programs.

When backed with the necessary resources, commitments from leadership, and instructor knowledge, digital technology can be a useful tool in many learning environments [30]. For example,

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2573-0142/2019/11-ART78 $15.00
https://doi.org/10.1145/3359180

teachable digital characters have been shown to increase children's learning-by-teaching [18], pedagogically grounded Kinect games have been shown to improve foreign-language learning [90], and digital-tangible displays embedded in public spaces have been shown to facilitate children's science learning [5]. The educational value of thoughtfully crafted digital experiences also extends to early childhood. Prior work has demonstrated, for example, that learning gains from *Sesame Street* can persist for a decade or more [34], and that preschoolers absorb content knowledge from the interactive television show *Blue's Clues* [8]. And this learning extends beyond traditional academic competencies; for example, media for preschoolers has been causally linked to gains in social and emotional development [73] and reduced racial bias [20].

Thus, as researchers and practitioners enact their agenda to develop high-quality ECE programs, there is good reason to explore the role technology might play in this learning environment. Prior work on ECE technology has primarily focused on teacher beliefs and how their leanings support or limit technology in ECE classrooms [15, 17, 43, 46, 61]. However, despite the numerous studies on teacher beliefs and technology integration in the early childhood classroom, work in this space has yet to draw any kind of user-centered design implications or lessons for app developers. This design perspective is sorely needed, as developers in this space currently fall short in their efforts to serve this audience. For instance, in 2018, researchers found that the overwhelming majority of apps for preschoolers that claim to be educational do not, in fact, provide experiences backed by evidence-based best practices for teaching and learning [24].

To bring a more explicit design lens to this space, we draw on *Uses and Gratifications Theory* (U&G), a mass-communication theory which considers how the *gratifications* users seek drive their *uses* of technology and the extent to which the affordances of the technology align with those gratifications [76]. We conducted an observational study at ten different early childhood education field sites, and we followed our observations with interviews with teachers and directors at these field sites. In doing so, we examined the situated context of use (through observations) and the underlying gratifications that motivate these use cases (through interviews). Specifically, we asked:

- **RQ1:** *What gratifications do teachers seek when utilizing technology in ECE environments?*
- **RQ2:** *What design guidance do these uses and gratifications suggest?*

We find that ECE teachers have well-formed ideas about the gratifications they are (and are not) seeking with respect to technology use in their classrooms. The gratifications they seek include: scaffolding technology literacy, regulating children's behavior, meeting developmental goals, supporting child autonomy, connecting and communicating with family members, and tracking data about children. One contribution of this work is a set of design recommendations grounded in these themes, including enhancing children's aural experiences and supporting child-directed data capture.

In addition to providing empirical data to sensitize designers to the needs of this user group, a second contribution of this work is an expansion of the U&G framework. In analyzing our data, we found that U&G provides a valuable framing for understanding the gratifications that teachers seek when using technology and sheds light on how designers might support them in these aims. However, it does not account for the ways in which these gratifications relate to other stakeholders (such as the children teachers care for), and we show how U&G can better model this space by differentiating between *direct gratifications* and *indirect gratifications.* Further, given that teachers were as likely to articulate gratifications that they felt were inappropriate (*e.g.*, stimulation and entertainment, or electronic babysitting) as they were to describe ones they sought, we also expand U&G to conceptualize *gratifications resisted* alongside the existing construct of *gratifications sought.* Through this expansion, we anticipate U&G will better address research questions posed of collaborative contexts, making it a more productive tool for the CSCW community.

2 RELATED WORK

2.1 Technology Use During Early Childhood

A comprehensive national census of digital media use among United States children (ages 0-8) reported that in 2017, almost every US household with young children had both a television and Internet access. The report found that 95% of these children lived in a home with a smartphone and 78% of children in a home with a tablet, up from only 8% of children who lived in a home with a tablet in 2011 [74]. Furthermore, in 2017, 42% of children (ages 0-8) owned their *own* dedicated tablet–up from less than 1% in 2011 [74]. Consistent with reports that children grow up in media-rich settings from an early age, an analysis of YouTube videos of young children using tablet computers found that 90% of two-year-olds showed moderate proficiency (or better) with the device [39].

Although the average child age eight and younger spent 2 hours and 19 minutes with media each day in 2017 [74], some work cautions against the use of digital media in early childhood. For example, prior work links exposure from fast-paced video content during the first years of life to subsequent attention disorders [92], technology in the bedroom to sleep disruption [26], background television to distracted parental relationships [44], and media violence to aggressive behavior [66]. As a result, the American Academy of Pediatrics and other bodies concerned with children's welfare have drafted policy statements cautioning against technology use in early childhood [19, 22].

However, recent policy statements present more nuanced guidance [63] and explain that concerns about risks must be balanced with potential benefits to young children [62]. This shift is consistent with recent research showing that risk-averse, restrictive approaches to technology use do not fit families' lives [53]. Parents themselves report a mix of concern and enthusiasm around their children's technology use, with some studies reflecting parental anxiety about inappropriate content, negative social and cognitive effects of technology, and potential detriments to children's health [37, 74]. However, a number of other studies of families with young children report parental optimism about the potential for media to support learning and creativity, educational opportunities, family bonding, entertainment, and babysitting [36, 37, 74].

2.2 Technology Use in Early Childhood Classrooms

In the United States, a third of children under the age of five regularly attend daycare, Head Start programs, and/or preschool [48]. On any given week, these children spend an average of 33 hours in the classroom [48]. From 2016–2017, Early Head Start (a federally funded program for children ages 0-3 from low-income families) enrolled 211,000 American children and Head Start (an equivalent program for children ages 3-5) enrolled 848,000 [28].

Early childhood education (ECE) teachers are increasingly incorporating technology into their classrooms. Traditionally, technology in the classroom was seen as an academic tool to support either whole-class learning or individual activities to support literacy and mathematics [16, 57]. More recently, however, teachers have begun incorporating a wider range of technologies for more open-ended activities [41]. For example, Jack and Higgins find that teachers experiment with tablets to make movies with children, YouTube to find dances children can copy, and digital cameras to support children's school projects [41]. Despite this widespread adoption, teachers report facing challenges integrating technology and wishing for more guidance regarding effective and appropriate use [41]. These challenges present opportunities for designers and researchers to better support this population.

A large body of work investigating technology integration in ECE classrooms has been framed through a beliefs lens. This work operationalizes "beliefs" as a complex set of knowledge, attitudes, value systems, and perspectives that influence how technologies [33] and pedagogies [67] are used in the classroom. Self-reported attitudes and beliefs can be strong predictors of how ECE teachers

value technology, and researchers have found that positive beliefs about the educational value of technology significantly predict actual use of technologies (including TV/DVDs, computers, and tablets) in ECE classrooms[15, 17, 35, 41]. Similarly, teachers' negative perceptions of technology create barriers to integration in the classroom [60]. Pre-service training and professional development for ECE teachers can influence their beliefs, and in turn, shift their likelihood of integrating technology into the classroom [43, 86].

Despite the predictive value of a beliefs frameworks, to our knowledge, this work has yet to be considered from a design perspective, and we did not find any literature in this space targeting a design audience or seeking to generate design implications. Prior work focuses on examining contextual factors (*e.g.*, administration, professional development, prior experience with technology) and the impact of these facotrs on technology integration, but it does not specifically examine how designers can better support educators in this space.

Some work, however, *has* explored the effectiveness of individual technologies in ECE classrooms. These targeted investigations assess the conditions under which a specific technology can produce learning gains and positive developmental outcomes. For example, prior work in both education and HCI has found that technology can be useful for enhancing numeracy [42, 65, 75], literacy [54, 75, 84], and social-emotional development [40, 50, 59]. Other work reports on teachers' use of technology to track children's development [52, 70] and, outside the classroom, to communicate with families [52]. Here, we build on this prior work by looking holistically at teachers' motivations and how they translate into technology use (and non-use). We found a dearth of studies that go beyond self-report to incorporate observational data, examine the situated context of use, or seek to identify novel design opportunities.

2.3 Uses and Gratification Theory

We rely on the Uses and Gratifications Theory (U&G) to more deeply understand ECE teachers' motivations for integrating technologies in their classroom [76]. U&G originates from mass-communications scholarship to examine why an audience gravitates to a particular medium, the ways in which different media gratify their audiences, and the social and psychological needs these media fulfill [76, 81]. U&G has a long history of providing a robust and rigorous approach to understanding how media (*e.g.*, newspapers, radio, TV) have captivated their audiences [76] .

Today, this perspective is equally effective in describing how newer technologies (*e.g.*, the Internet, social media, computer-mediated communications) continue to be used and adapted [81]. The interactivity of internet-communication technologies (ICT) allows for new conveniences, diversions, relationship developments, and intellectual stimulation [76, 81], which fulfill specific social, psychological, and community needs–labeled "gratifications" in the U&G paradigm. Prior studies use U&G to understand the gratifications users receive from social media (Facebook/MySpace) [7, 71, 72], music listening applications [47], social games [38], picture-tagging [29], and more. We chose to leverage U&G because of the theory's focus on uses, goals, and motivations, which can translate into design insights. In this study, we examine the uses ECE teachers have for technologies, the needs that are met through these uses, and additional unmet needs, which might suggest design opportunities for this space.

3 METHOD

We conducted a seven-month field study [56] of ten child-care centers and daycares in the greater Seattle area, United States from September 2018 to March 2019. We conducted non-participant observation [27] of classrooms at each field site, which we followed with semi-structured interviews with teachers and directors. Each of the ten environments is characterized in Table 1.

Table 1. Demographic characteristics of the early childhood education centers

	Center Type	Cost of Full-Time Child Care Per Month (5 days/week) for Preschool	% Of Students Receiving Government Subsidies	Age Range of Children in Observed Classroom	No. of Children in Observed Classroom	No. of Teachers in Observed Classroom
1	Inclusive Child-Care Center	$1,330	8%	2-5	13	2
2	Child-Care Center	$1,800	0%	3-5	18	3
3	Child-Care Center	$1,530	60%	3-5	14	3
4	Family Child-Care Home	$1,425	40%	1-2	5	2
5	Child-Care Center	$2,290	0%	N/A	N/A	N/A
6	Child-Care Center	$1,550	10%	3-5	14	3
7	Inclusive School Community	Free*	35%	3-5	13	3
8	Family Child-Care Home	$1,750	0%	0-5	9	3
9	Child-Care Center	$1,660	0%	3-4	14	3
10	Child-Care Center	$1,600	0%	3-5	11	2

*Free for all except those in the Seattle Preschool Program who pay the state directly.

3.1 Participants

We used Facebook, personal contacts, and a state database of licensed child-care providers to identify ten different early childhood environments in Seattle, Washington. Once a potential ECE environment was identified, the research team emailed, Facebook messaged, and cold-called directors to determine fit and interest. We included licensed centers, schools, and family child-care homes that: 1) serve children between the ages of zero and five, and 2) self-reported using some form of technology regularly. We explained to each director that we were interested in observing a preschool classroom, but that we would not be directly interacting with or taking photographs of the children. Although centers had different policies and comfort levels around allowing outside visitors, many were not only used to having visitors in the classroom, but had also previously worked with researchers from the university during the implementation of a state-wide preschool quality-rating system. Hence, centers largely felt comfortable with the research team and did not require background checks or explicitly ask for parental permission before our field visit. Each field site received a $45 Amazon gift card as a thank-you for their participation. All names in this study are pseudonyms.

Of the ten field sites, seven were licensed as child-care centers where care is offered in "commercial, privately owned, school or faith-based spaces" [64]. Two of the environments were licensed as family child-care homes, where care is offered in a provider's home. One environment was an early childhood school community where researchers, students, and teaching professionals collaborated to train teachers and provide services to children. Table 1 provides descriptive statistics for each of the ten environments.

The majority of the selected classrooms served preschoolers between the ages of three and five, however, three classrooms served infants and toddlers as well. Two of the environments provided inclusive education to children both with and without disabilities. The child-care environments we visited were more expensive than the regional average. The median cost of full-time care at child-care centers in our study was $1,600/month for preschool-age children, in contrast to the median cost of full-time care at child-care centers in the surrounding area of $1,122/month [1]. For

family child-care homes, the median cost of care in our sample was $1,588/month, higher than the $867/month median cost of all family child-care homes in the surrounding area [1]. On average, 15% of children at our field sites received some form of financial aid, which is less than the city average of 60% [1].

3.2 Procedures

The sites we visited had schedules that included meal times, nap time, outdoor time, teacher-initiated group activities, and choice time (where each child chose an activity to work on independently or collaboratively with other students). The research team visited each environment in the morning and spent up to two hours at each field site, usually starting with approximately one hour of non-participant observations. We conducted observations in the morning at the request of the schools, as all centers had an extended period reserved for napping during the afternoon. During observations, we took detailed notes, focusing on children's and teachers' interactions with the tools and technologies in the classroom. These notes were later transcribed into ethnographic fieldnotes [31].

Although we had opportunities to converse with the teachers during observations, we also chose to conduct formal interviews with directors because they had more time to dedicate during the school day. These interviews were most often conducted by one or two members of the research team in the director's office. At Centers Four, Six, and Eight, directors were more involved in classroom operations, thus interviews were conducted during low-activity periods when other teachers could easily manage the entire classroom. During the semi-structured interviews, we asked directors about their philosophy regarding technology use at school, their goals related to using the technologies that they had chosen to adopt, and their ideas of future tools they would like to incorporate in the classroom, if any. For example, our protocol included (among others) the questions:

- *What's the goal of using this technology in the classroom?*
- *Why do you use this piece of technology for that goal?*
- *Can you come up with a situation where you think technology could be useful in the classroom?*

During the interviews, directors were often interrupted by a variety of tasks and teachers needing support. Because teachers and directors at child-care environments were incredibly busy, we found the need for our procedure to be flexible in order to accommodate their schedules. Although we tried to conduct observations first and use those notes to guide the interviews, that protocol was only possible at seven of our field sites. In one case, the interview and observation happened concurrently (Center One), and in another case only an interview with the director was possible (Center Five). At Center Seven, the interview occurred first. If any questions emerged after the field visit, we emailed the directors. We audio-recorded interviews for later transcription.

3.3 Analysis

Within seventy-two hours of visiting each field site, the primary researcher organized jottings into ethnographic fieldnotes. Within two weeks of visiting each field site, the primary researcher transcribed the interviews. Overall, the primary researcher transcribed just over 312 minutes of interview data, approximately 14% of which was data from teachers; the remaining was interview data from directors. On average, a director interview lasted 29 minutes and a conversation with a teacher lasted 8 minutes. The first pass of transcription was done using an online software called *Temi* [4], with a second manual pass to correct errors.

Analysis was performed iteratively in parallel with data collection. Each member of the research team analyzed field notes and interview transcripts individually and clustered data into themes.

The primary researcher used an online whiteboarding platform called *RealTimeBoard*[2] to lead affinity diagramming. In the initial rounds of inductive analysis, the research team did not have a set of preconceived groupings and allowed themes to naturally emerge. After multiple rounds of iterative discussion, the team collaboratively identified the alignment between the U&G construct of *gratifications sought* and many of our emergent themes. Subsequently, we performed multiple rounds of deductive analysis with collaborative discussion between rounds, ultimately converging on two umbrella themes of gratifications sought and gratifications resisted, with eight sub-themes that fit within these categories. Each of these sub-themes are described in detail below.

4 RESULTS

Table 2. Summary of Gratifications Sought and Resisted

Gratification Sought	**Description**	**Example**
Scaffolding Technology Literacy	Scaffolding children's introductions to technology and technology-related skills	"*So 21st century technology in the classrooms right now looks like an old typewriter…It's just kind of introducing them [the students] to the concept of a keyboard, and the functions of the keyboard too. Maybe in the future, move them into the direction of, okay, we've used a typewriter, we saw how a typewriter was able to create a sheet of paper with letters on it, to taking it to a computer that has a keyboard.*" (Alex, program director, Center Five)
Regulating Children's Behavior	Nudging students toward particular moods or behaviors in particular contexts	"*When they hear the prelude [to the song], that lets them [the students] know that we're going to have cleanup soon. So it's just part of our daily schedule, so they can kinda be empowered to know what they're supposed to be doing.*" (Ryan, director, Center Three)
Achieving Curricular and Developmental Goals	Using technology to support developmental growth and curricular learning	"*The goal of them coloring while listening to music is creative self-expression, pre-writing skills, responding to rhythmic patterns as well as a sensori-motor activity. We notice that when they are listening to calm music their lines are curved and gentle, whereas while listening fast upbeat music their lines are sharp and fast.*" (Jody, director, Center Two)
Supporting Child Autonomy	Empowering students to take an active role in driving their learning experience	"*The kids actually take hold [of] the book and then we do the story tape with it. And they've figured it out. We did that a lot last year when we had a little older group, so right now we have a lot of young ones.*" (Sam, director, Center Six)
Communication and Connection with Family	Using technology to communicate and build relationships between family members, students, and teachers	"*Photos are helpful for the parents because they'll want to know about the day and the kids will say 'I don't know,' so it gives them something to talk about.*" (Kate, teacher, Center Ten)
Tracking and Data Collection	Documenting children's developmental progress and learning	"*There are certain assessments that we have to do, and they're all online, so teachers have to either use tablets, an app, or a phone, a computer to upload documentation three times a year, and then the city tracks that.*" (Ryan, director, Center Three)
Gratifications Resisted	**Description**	**Examples**
Stimulation and Entertainment	Resisting the use of technology for passive entertainment and stimulation	"*The main thing is to use technology in a way that will teach kids about how technology is used, but they won't passively be entertained by technology. So for example, with the music or with the tablets, we never have them just watching a video on YouTube, but we want them to know that technology is something people use. So we're not hiding the tablet away when we're writing. So whenever we're documenting what we're doing, if they ask questions or they're paying attention to what were doing, we will explain to them how we're using the technology and why it's useful to us…so they can see technology as something that's useful rather than entertainment.*" (Sanjay, teacher, Center Three)
Electronic Babysitting	Resisting the use of technology as a babysitter	"*It [technology] can add to a program, it just depends on how intentional you are and if you're using it as a babysitter versus as aid, y'know. If you already have a great curriculum and a program, and you're adding it in as an another layer, it's great.*" (Jody, director, Center Two).

4.1 Gratifications Sought

We found that the gratifications teachers were seeking when they chose to bring technology into the classroom clustered into six overarching categories: 1) *scaffolding technology literacy*, 2) *regulating children's behavior*, 3) *achieving curricular and developmental goals*, 4) *supporting children's autonomy*, 5) *communicating and connecting with families*, and 6) *tracking and data collection*. Teachers and directors articulated these gratifications during interviews, and we observed how these goals

translated into usage scenarios during our observations. Table 2 summarizes the results of these interviews and observations.

4.1.1 Scaffolding Children's Technology Literacy. One of the gratifications teachers sought when introducing technology in the classroom was to support children in developing skills to navigate their media-rich worlds. For these educators, such skills include developing context-appropriate usage habits, learning to use technology as a research tool, and exploring their role and relationship with technology. For instance, at Center Nine, the director spoke about the school's emphasis on technology modeling. Children at Center Nine are not permitted to watch videos alone; instead "*children watch videos with staff, with staffing model[ing] active viewing skills, which will help children to use computers and television actively at home.*" The research team also observed teachers using their phones and tablets to model technology-mediated research behaviors at Centers One, Two, Three, and Eight. For instance, the director of Center Two gave an example of how the teacher was "*modeling kinda the research process*" by using her iPad to find examples of Native American dwellings. At Center Three, adults reported that this modeling is effective; the director described how some children have watched their teachers and learned how to use the Google voice assistant: "*They'll go to Google and ask questions. We found a moth in some leaves we collected, so this little boy Yosef pushed the speaker and was like, 'Ok Google, what do moths eat?'*"

A second strategy teachers employed to support children's technological literacy was to use older or deconstructed technologies as toys. At Center Five, the center replaced their touch-screen computers with old keyboards, calculators, and typewriters to better scaffold their introductions to technology. Alex, the program director, explained that these older technologies, "*introduce them [the students] to the concept of a keyboard, and the functions of the keyboard too*," allowing them to gain experience with a tool that will someday become an essential part of daily life. Additionally, Center Five scaffolded introductions to technology by engaging children in "deconstructive science" where children had opportunities to take apart toys and remote controls. Teachers explained that this activity served to demystify technologies and help children become more familiar with the tools around them.

At Center Six, we observed a girl walking around with a black, plastic, hand-held phone to her ear while dangling a toy camera in the crook of her elbow and holding a set of keys in the other hand. She turned to a nearby teacher and announced, "*I'm talking to somebody.*" We also saw this type of pretend play with discarded technologies at Centers One, Eight, Nine, and Ten. Teachers explained that these types of interactions are critical to helping children explore their roles in a technology-rich society. Sheryl (director, Center Six) explained that imaginary play gave children a chance to, "*act out and figure out some of their… roles, what they see and what they see from their parents or from just society in general.*" Across these and other examples, we observed teachers choosing to facilitate usage instances for children, because they see this access as useful preparation for their students.

4.1.2 Regulating Children's Behavior. Upon entering a noisy classroom at Center Two, we immediately observed one of the teachers use her iPad to play an instrumental playlist of flute music. The teachers then used the music to explicitly regulate noise and behavior. When the children became louder, the teachers said, "*Guys, I cannot hear the music. I need you guys to be a little quieter in here*" and, "*It's too loud in here; I cannot hear the music*" (Jessie, teacher, Center Two). Later, the director added that classroom environments can be chaotic at times, and it is helpful to have "*a focus of calmer music*" (Jody, director, Center Two), to give children a guiding tool for modulating their own voices. When we asked about the type of music the teachers choose and the how they make those choices, the director responded:

> "*It depends on what they're doing. This morning they were in their learning centers and they were focusing on literacy and science. They'll just have a quiet background instrumental music, I would say it's a mix, depending on their focus and what you want their activity level to be. It's pretty intentional, I would say, how they use it*" (Jody, director, Center Two).

Thus, we see through interviews that teachers are actively and intentionally seeking the technology-mediated behavior regulation we observed in the classroom.

Music, in particular "*soft music*" (Kris, director, Center Four) or "*lullaby music*" (Jody, director, Center Two) was very popular at nap time; we observed or heard about it being used at Centers One, Two, Four, Six, Eight, Nine, and Ten. Teachers used it to set the mood for the classroom and cue children that it was time to rest. At Center Three, teachers also used music to cue children to clean up. When we visited Center Three, the children were nearing the end of free choice time. As one teacher began playing instrumental music from an iPod, another teacher explained that this "*prelude song*" signals to the children that it is time to wrap up activities. After the prelude song, the teacher played the clean-up song, at the end of which, children were supposed to have finished cleaning. The director explained that providing these cues gives the children more control over their own time:

> "*When they hear the prelude, that lets them [the children] know that we're going to have cleanup soon. So it's just part of our daily schedule so they can kinda be empowered to know what they're supposed to be doing*" (Ryan, director, Center Three).

We observed this approach to be effective, and students worked along with teachers to ensure they finished cleaning up by the end of the song.

In these usage decisions, teachers sought structure, order, and efficiency, while simultaneously being attentive to children's need for predictability and control over their environment. Although teachers could have employed other non-digital strategies (*e.g.*, ringing a bell, using their voices), we observed that digital music was an effective tool for satisfying teachers' and children's gratifications while scaffolding fun and orderly transitions.

4.1.3 Achieving Children's Curricular and Developmental Goals. We observed that centers strategically aligned digital activities with curricular goals, and the most common gratification sought was support for children's learning and development. For example, a number of centers used technology to scaffold language, print literacy, and communication skills. At Center Eight, Jamie (director) used a stand-alone keyboard to "*reinforce the alphabet*," and she kept a digital photo frame that she used to ask children to explain their family pictures as a way of, "*practic[ing] their public speaking skill[s]*." Center Two used audio books during circle time to add word-diversity to their language program.

At Center Seven, an early childhood school that provides special education services to children, Juan, the director, spoke about the ways teachers used a variety of tablets and apps to help students with different learning challenges. He explained that one of the primary advantages of technology is its ability to provide individualized support for each child. Juan described apps the center uses to help children with language delays practice matching sounds and letters. For children with fine motor challenges, teachers use tablet apps to scaffold handwriting skills: "*the iPad is very motivating and it's a lot easier for them just to use their finger to trace a word. Then you don't have to worry about the grip.*" Juan also spoke specifically about a popular app Proloquo2Go [3] that allows students to build simple sentences and then verbally produces these manually constructed sentence as audio output. As the school has many non-verbal children, the augmentative communication support is of enormous and critical value.

Digital music not only supported behavior regulation (as described above), but also fulfilled learning-oriented gratifications. At Centers Two and Three, ECE teachers used digital music to support motor skill development in children. The director of Center Two described how teachers used the Spotify streaming music app to play "action songs" that directed children to move and freeze their bodies in certain positions to practice "*gross motor and sensorimotor skills.*" Through these action songs, "*children become aware of their bodies and practice self-regulation*" (Jody, director, Center Two). Center Three, a child-care center required to regularly document progress on developmental goals to receive state subsidies, also used musical games and dancing games as opportunities to observe balancing skills, gross motor manipulative skills, and other competencies they document for the state. In other instances, teachers described musical games to support self-expression (Center Three), audio-book listening stations for literacy (Centers One, Two, and Nine), and coloring activities aligned with classroom music (Center Two), with a goal of supporting, "*creative self-expression, pre-writing skills, responding to rhythmic patterns,... and sensorimotor activity*" (Jody, director, Center Two).

4.1.4 Supporting Children's Autonomy. At times, teachers incorporated technology in the classroom for the explicit purpose of giving children control over their environment and fostering autonomy. Teachers supported child-choice by letting children pick music, take pictures and videos, and generally take an active role in driving their learning experience. At Center Three, the director spoke about having children pick the song that cues their transition to clean-up time saying:

> "*When they pick a song, we add it to a playlist. So then I show them how to go to the library on YouTube and show them the playlist, and then they scroll down to see what song they want. Or if it's not on there, they'll sing the song and I'll... help them... sound out what the song is. They can help pick the letters and then we add it to the playlist in case they want to hear it again.*"

Ownership around music was a popular theme, and at Center Nine, the teachers found the children wanting to be more involved in the process of playing the music. They had previously used a laptop to play music but bought a record player to give children an opportunity to engage in, "*the process of, like, putting it on and watching it spin; and they all, like, know to lift the needle and put it down and it's more like they can see it spinning, so they can see the process happening.*" Teachers recognized, however, that children may not always be ready to take full control of their experiences with technology and scaffolded their autonomy by age. Sam, the director from Center Six, describes story tapes where, using a CD player,

> "*the kids actually take hold [of] the book and then we do the story tape with it. And they've figured it out. We did that a lot last year when we had a little older group, so right now we have a lot of young ones.... Last year we had let them actually turn on and use the tape, the CD players themselves.*" (Sam, director, Center Six)

Teachers also sought to support children's autonomy by allowing them to record and share their own memories, selecting for themselves what is meaningful enough to deserve preservation. Sam from Center Six described how the children went on field trips to collect "*records.*" The lead teacher took the class:

> "*To the garden, the pea patch down here. And they, she let the kids take pictures of it and in the different seasons and, and what it looked like and things like that.*" (Sam, director, Center Six)

These records provide a way for children to take an active role in their learning and record what they find valuable. Other centers used photography as a form of art and self-expression and shared photos taken by children on the board outside the classroom or with families. At Centers Three, Nine,

and Ten, teachers described that they sometimes have children "*walk around and take pictures and videos of what their friends are doing*" (Ryan, director, Center Three). Teachers found it "*interesting*" to see how children viewed the world and how they decided to express themselves (Kim, director, Center Ten). At Centers Three and Six, teachers gave children cameras to take pictures of structures they were building so they could share their work and record their progress. The director of Center Three explained that children take pictures of their own work with the tablet:

> "*(We involve) them in documenting their work so that they can share with friends during circle time or look at it again the next time they're playing in the same area or playing a similar game. If they want to kind of build on something over a period of days, then they might take a picture then work on the same game again then take a picture again.*" (Ryan, director, Center Three)

Across these and other examples, we saw that teachers used technology to meet children's need to autonomously manage and draw meaning from the world around them.

4.1.5 Providing Families with Communication and Connection. Through newsletters, emails, weekly stories, photos, videos, and phone calls, every center regularly shared information to obtain gratifications around connecting and communicating with students' family members. Teachers sought to connect directly with parents for communication related to administrative tasks, billing, classroom information, and updates. These strategies were tailored to families' abilities and comfort with each of these technologies.

For example, at Center Eight, a bilingual Chinese-English daycare, many of the families were of Chinese origin, so the teachers used *WeChat*, a Chinese texting platform, to communicate with the families. At Center Five, the majority of parents worked at large technology companies, so the teachers uploaded information to an application which the families could track in real-time using their phone or computer. The director of Center Seven said that they have families from such diverse cultures (eight spoken languages) that the approach to communicate with them has to be personalized. He saw communicating with English language learners (ELL) as the single "*biggest problem*" for child-care centers, and he spoke passionately about how this challenge, "*could be addressed by technology I think more easily than by what we're doing right now, which is paying for interpretation and translation.*" Juan envisioned an app that had a collection of videos, pictures, and songs, with the option to present them in different languages.

Besides strategies to support parent-teacher communication, each center also employed its own strategies to support parent-child connections. Teachers at Centers Three and Ten explained that sending parents photos and videos helped parents better engage with their child around school. Sanjay (teacher, Center Three) explained that daily videos were especially helpful:

> "*A big issue for parents is when they pick up their kid. They say 'What did you do today?' and then the kid says 'nothing' or 'I don't remember.' So the video is a great way for them to have a more detailed question with the child so they'll be able to share what they did today… also for parents who don't drop off or pick up very often, it's a good way to see what's happening throughout the day and to then be able to talk to the child about their day*" (Sanjay, teacher, Center Three).

Learning stories were also a popular way for teachers to encourage parents to engage with their child's development. Teachers at Center Nine found that documenting and sharing children's key learning and developmental moments helps parents better appreciate and support their child's developmental progress.

Finally, we noticed that educators were actively trying to create community–inside and outside the classroom. At Center Eight, Jamie (director) kept a digital photo frame of the families so,

"*(Children can) look at them when they miss them (their family members) or they can just look at other people's families.*" She added that the digital photo frame helps the children learn about each other. At other centers like Center Three, the teachers wanted children to be able to learn more about one another's cultures. They spoke about playing Korean music and Bollywood music to bring children's outside lives into the classroom. At Center Five, the teachers shared pictures, videos, and notes about the child's behavior with their parents regularly throughout the day and found that this level of communication helped build community. Parents learned, not only about their children, but about the other children in the classroom. Alex (program director, Center Five) explained that the parents, "*can see that their child is interacting with other children in the classroom. Maybe they're friends with the family of that child, so it's creating a sense of community.*"

4.1.6 Tracking and Data Collection for the Centers. Finally, teachers used technology to satisfy gratifications for data to track students' development. The centers and day cares we visited collected data on their students for two different reasons: to share with their students' families and to meet state or city requirements. Centers Five, Eight, Nine, and Ten all had children from higher income families that did not receive any subsidies from the state, so these centers collected data that they felt parents would most appreciate and that most aligned with the values of the center. At Center Five, Alex, the program director, explained that teachers use tablets to record information about each child's nap, feedings, bowel movements, and progress toward developmental goals because families, "*expect that information.*" At Center Ten, a center than emphasized social interactions, teachers transitioned from using tablets to document observations to jotting observations by hand to remain more "*present*" with the children (Kim, director, Center Ten).

The examples presented above were drawn from centers that voluntarily chose to collect data, but a number of centers were required to collect data to receive funding from the state or city. In 2018, Centers Two, Four, Five, Six, and Seven began collecting data on student attendance using tablets when it became a state-mandated requirement for every child who receives subsidies. Center Three participated in a city subsidy program and were thus required to document "*fifty different developmental goals…twice every three months*" (Sanjay, teacher, Center Three). These assessments are, "*all online, so teachers have to either use tablets, an app, or a phone, or computer to upload documentation*" (Ryan, director, Center Three). Teachers at multiple centers found the process of electronic tracking to be a burden that changed the focus of their work from playing and learning to monitoring.

4.2 Gratifications Resisted

Although not something we initially planned to probe, we found that during our conversations, teachers and directors were just as likely to speak about the role they did *not* want technology to play in the classroom and the gratifications that they were not interested in obtaining for themselves or for students. These clustered into two types of gratifications they resisted: 1) *stimulation and entertainment*, and 2) *electronic babysitting*. Table 2 summarizes the gratifications that teachers resisted when incorporating technology into their classrooms.

4.2.1 Stimulation and Entertainment for Children. Many of the teachers we interviewed voiced concerns about the impact that screen time may have on children's attention and development. We observed teachers actively resisting certain forms of technology to prioritize resisting the gratifications they found problematic. Jody (director) from Center Two commented that her students do not have access to "*screens*" in the classroom because she felt entertainment technology, "*really affects their attention span…they have a harder time sitting in circle time 'cause they're used to constant engagement.*" Similarly concerned, Center Five, which used to have touch-screen computers, removed them from their classrooms.

Teachers at centers with play-based curricula or curricula based on social interactions voiced concerns that time with stimulating technology that captures and holds children's attention could displace those higher-priority activities. Jordan, a teacher at Center Ten, explained that she does not introduce any technology in the classroom because, "*in here is the place for social interactions and if they're using technology, then they're not interacting with each other.*" And when teachers do allow students to use technology independently, they are wary of software that is inappropriately stimulating. The director of Center Seven explained that the tablet apps that the preschool uses for early literacy and math make getting the wrong answer just as exciting as getting the correct answer, which he finds problematic, as it rewards incorrect answers. Similarly, at Center Eight, Jamie (director) found that toys that could talk to children were stimulating but disrupted natural language development. She explained that: "*for younger kids, you can't really learn how to speak [from] the electronic toys. You have to see how the adults are pronouncing the words and all that stuff and then having eye contact, so for that that I just [let] the battery drain.*"

These concerns about the effects of using technology led centers to develop school-based philosophies around what appropriate use looks like and to set limits on technology integration. Sanjay (teacher, Center Three) said that "*especially with younger kids, it's easy to over-expose them to technology.*" Therefore, Center Three developed a philosophy that resists allowing children to, "*passively be entertained by technology.*" At Center Three, teachers are required to complete ten hours of training per year where they are taught that students learn very little from technology unless that usage is supplemented with interaction with another human being. These research-grounded trainings are the reason why the school has resisted using technology to passively entertain or stimulate their students and is instead looking to introduce more interactive, hands-on, and collaborative tools. Directors at other centers also were also interested in experimenting with smart boards that could serve as "*child interaction stations*" (Alex, program ,director Center Five), motivated by a desire to avoid passive entertainment technology in favor of more hands-on engagement with technology.

4.2.2 Electronic Babysitting for Children. Teachers and directors at every center were intentional about their technology use and were careful to use it not as an babysitter, but rather as a tool "*to enhance either the curriculum or your strategy*" (Juan, director, Center Seven). Jody, the director at Center Two, explained:

> "*(Technology) can add to a program, it just depends on how intentional you are and if you're using it as a babysitter versus as aid. If you already have a great curriculum and a program and you're adding it in as an another layer, it's great.*" (Jody, director, Center Two)

One of the reasons teachers cited for being so intentional with their technology use is that they believed that parents did not regulate technology use at home and hoped that the school environments could compensate. Teachers expressed the view that adults receive gratifications from electronic babysitting, but that this should be resisted for children's benefit. Jamie, the director at Center Eight explained that: "*I know that they're watching TV a lot because parents are busy, right, or using an iPad a lot, so I don't need them to do the same here.*" Sam (director, Center Six) felt similarly:

> "*So you know that a lot, most of the kids, their parents have computers… They play games on their parents' phones and things like that. So I don't feel it should be a part of preschool.*" (Jaime, director, Center Eight)

Teachers also explained that *they* should resist the urge to receive gratifications from electronic babysitting. Center Nine even had an official "Technology Policy" for the school as well as unofficial guidelines that capped screen time at a maximum of two hours per day per classroom. These examples reflect a common sentiment we encountered across centers, wherein teachers

expressed concerns about children's exposure to technology generally and positioned themselves as gatekeepers creating technology-free learning spaces for children. In this case, while technology might satisfy children's need for fun and excitement, the teachers choose to resist, even when technology could give them a break from the children.

5 DISCUSSION

U&G provides insight into the motivations, goals, and needs driving ECE teachers to incorporate technology into their classrooms. These insights present an opportunity for designers to better support this population. We first contribute a set of design priorities grounded in the way teachers chose to use technology and the reasons for these choices. Second, in conducting this investigation, we found the U&G framework to be both highly productive and yet limiting in its ability to explain our results. Thus, in addition to presenting design ideas, we also contribute an expansion of U&G to better capture the data in our study and CSCW concerns more broadly.

5.1 Designing for ECE Classrooms

Our results describe the gratifications teachers seek and how those gratifications translate to usage scenarios in the classroom. In this section, we provide five design priorities for designers creating tools and technologies for ECE classrooms. These design priorities provide an evidence-based jumping point that can guide the ideation process. Although some of these tools and technologies exist in different settings, the five design priorities provide insight to how these technologies could be tailored to an ECE context and *why* they would be valuable to teachers.

Aural Experiences. Tools that used an aural, rather than visual, modality were some of the most popular in the classrooms we visited. Teachers at Centers One, Two, Four, Six, Eight, Nine, and Ten used music to calm children, cue routine behavior, and support transitions from one activity to another. Most ECE classrooms have a routine schedule that they follow every day, which includes nap time, meal times, circle times, and free choice times. Designers can support teachers and satisfy their need for a well-regulated classroom by creating aural experiences that modulate mood and behavior. For example, designs for this scenario might include automated or context-aware triggers for music that map to activities like napping, cleaning, or circle time and the transitions between these events. Teachers at Center Nine also mentioned that they wanted children to be involved in the process of playing the music. To best satisfy gratifications around children's autonomy, designers might also consider how children might participate in driving aural experiences, perhaps by designing user interfaces for young children to support curating music selections and aligning them with classroom routines.

Scaffolding Digital Literacy. Consistent with prior work by Marsh, we found that many centers (One, Eight, Nine, and Ten) encouraged imaginary play with outdated or discarded technologies as an early form of teaching digital literacy [51]. At Center Five, teachers encouraged students to engage in "deconstructive science" to explore the various functions of a phone, while other centers (Three, Six, Nine, Ten) encouraged children to take pictures on their own with cameras and phones. Teachers' interest in scaffolding children's introduction to technology suggest an opportunity to design for this use case. Such designs might include a deconstructed or modular phone that enables safe, age-appropriate play with its individual components. Or they might include interfaces that support children in becoming more familiar with a limited number of functionalities within a larger piece of technology. Devices with limited functionality to support use cases teacher value–such as taking pictures or playing music–would allow ECE educators to gradually introduce certain functionality without enabling passive entertainment or stimulation–gratifications they are specifically resisting. These types of tools and toys would empower teachers to gradually

introduce children to higher-fidelity technologies and personalize those introductions for children with different levels of familiarity with technology.

Child-Directed Data Capture and External Reporting. At almost every field site, we found teachers capturing data for external reporting (to parents or to state agencies), and we found that the process of documentation presented large challenges across centers, consistent with prior work by Basford and Bath [9]. Separately, at some sites (Three, Six, Nine, and Ten), teachers supported children in capturing their *own* data, empowering children to record memories, capture meaningful artifacts, and choose what to track and share. These findings suggest value, first, in designing for either one of these two forms of data capture independently (*i.e* designing for outside reporting, or designing for children's autonomous self-tracking). Further, they also suggest a potential opportunity to combine these two forms of tracking, and to design tools that give children autonomy to produce (or participate in producing) the records teachers must currently create through their own self-directed efforts. This is consistent with prior work that suggests teachers and administrators are enthusiastic about new digital tools that can ease the heavy burden of paper work [70].

To support this scenario, designers might create interactive and playful toys and games that align with curricular and developmental goals. When certain goals are met, documentation could be automatically sent to the appropriate state and city departments as well as to family members. Involving children in an automated or semi-automated documentation could reduce teachers' heavy data collection burden (*e.g.*, teachers at Centers Three and Ten found it challenging to be fully present in the classroom because of the large burden of documentation) while simultaneously satisfying teachers' gratification to support children's autonomy. In doing so, design solutions would have to navigate privacy and security concerns, as prior work has shown for example, that children are not always aware of when the data they capture is accessible to others [55].

Discretization of Functionality. *Undesign* [68] refers to designers or researchers intentionally eliminating technology and includes a spectrum of activities that run from obstructing particular uses of technology to eliminating a technology altogether. Undesign reflects resistance to technology on the part of designers, and it is complemented by *non-use*, which describes similar resistance to technology on the part of potential users [77].

In our findings, we see the themes that motivate undesign and non-use in the gratifications that teachers resist, and we find that teachers choose to use and *not use* technology in their classrooms in intentional ways. In many cases, we observed a teacher using an array of dedicated devices for their use cases, rather than using one multi-purpose device to accomplish all tasks. Teachers used speakers for music, laptops for communication with families, discarded technologies for children to play with, and tablets for taking pictures. Centers Two, Four, Five, and Six had tablets or computers dedicated solely to the child's sign-in and sign-out process, and Center Two had multiple tablets–one for the sign-in and sign-out process and another identical tablet for taking pictures, playing music, and modeling research activities. Center Ten had an Amazon Echo they used only as a speaker to play music. This discretization allowed teachers to be precise and intentional with each piece of technology they introduced to their class.

We recommend designs for tools in ECE classrooms with specific, dedicated purposes such as, speakers to choose and play music, cameras to take and send pictures, and toys that automatically track progress on developmental goals. Not only would technologies that limit functionality and operate in a single form factor best serve this user group's motivations to resist certain gratifications, but these technologies could also be offered more affordably.

ELL Communication. Finally, Center Seven, the director described a desire for technology to support him in communicating with the increasingly diverse set of families and children in his school. Although this theme did not emerge across our sample, it hints at a use case and gratification

that might apply to other schools. We do not have enough data to make claims about this need, but future work to explore the prevalence of this concern, the effectiveness of current off-the-shelf solutions, and additional design opportunities that have not yet been explored but could be of great value. Based on our limited data, there may be opportunities to better support music and video content in the classroom, email translation, and language-practice apps designed specifically for ECE classrooms.

5.2 Expanding the Uses and Gratifications Perspective

Through the mass-communication perspective of U&G, we see that teachers in this study use technology intentionally to achieve a concise and thematic set of gratifications. However, we also found this theoretical perspective as just 'uses' and 'gratifications' alone to provide an incomplete description of the factors influencing teachers' decisions. Thus, we propose two expansions to the U&G framework to more comprehensively model their behaviors and motivations.

Our first expansion seeks to account for the pushback teachers expressed *against* the gratifications they and other users sought. This resistance reflects one form of what prior work in HCI refers to as *non-use* [77, 87]. The second expansion accounts for the decisions teachers made to satisfy gratifications sought by *others* (specifically, children and parents). By evolving U&G to account for this indirect, collaborative gratification-seeking, the theory has the potential to better account for the concerns of CSCW investigations.

5.2.1 Gratifications Resisted and Non-use. Teachers and directors frequently and spontaneously brought up potential gratifications that they choose to resist (*e.g.*, entertainment, electronic babysitting), describing aspects of technology use that they might value or enjoy but want to guard against. This vigilance is consistent with prior work in HCI and CSCW documenting pushback against technology, a common form of *non-use*. Baumer and colleagues define non-use as a continually re-negotiated sociotechnical practice of deciding how and when to engage with technology [12]. Though non-use can take many forms (including abandonment [32], death [21], and non-volitional use [10]), one widespread type of non-use–which has received increasing attention from HCI scholars–is technology resistance, wherein users deliberately avoid or set limits on particular patterns of use.

For example, existing literature describes users giving up Twitter for Lent [78], attempting to cut back on smartphone use [45], and handing over their Facebook passwords to friends while locking themselves out of their own accounts [11]. Users of casual games, social media, and a host of other technologies report that they enjoy these experiences but wish they could reduce or change their patterns of engagement [45, 49]. And many users report deleting or deactivating technologies they use precisely because they find them too gratifying [11, 25, 85].

Prior work on non-use calls for researchers to give as much thought and attention to *non-users* as to *users* [77]. This call to action resonates with the findings we report here, which show the utility of expanding the U&G perspective to include these existing considerations of resistance. Like the gratifications users are *seeking*, the gratifications they resist also foreground the fact that people are active agents within sociotechnical and CSCW systems. In its original conception, U&G offered an advance over traditional media effects perspectives, in that it portrayed consumers as active participants of their own media consumption rather than as simple, passive recipients of media produced by others [76]. Here, we find that users' active participation is more than a product of their own active desires; their choices also stem from acts of resistance and pushback to protect themselves and others (children) that may be perceived to be more vulnerable to technology. By accounting for the gratifications users both seek and resist, we can model the resulting uses (and

the factors undergirding them) with higher fidelity, thus allowing CSCW scholars to make stronger claims about usage of technologies.

This expansion of U&G has practical–in addition to theoretical–utility. When considering only the gratifications teachers are seeking, we find a rich array of valuable uses of technology that include educational experiences for children, coordination of students and classroom management, socialization and interpersonal connection, and organizational administration. But by expanding to consider the gratifications teachers are resisting, this picture becomes murkier. Experiences that are enticing and highly engaging for children offer gratifications, but not always ones teachers want to satisfy.

5.2.2 Direct and Indirect Gratifications. We also found that U&G did not account for the stakeholders teachers were considering when they made usage decisions. Many of their decisions were motivated by gratifications for students, including students' need for autonomy, information, or, in the case of the alternative communication devices used in the inclusive preschool, fundamental communication. At other times, teachers were taking photos not for themselves but to gratify parents. Teachers chose to collect data on the students with devices (even though it was cumbersome) to satisfy their administrators' and centers' needs.

By combining a CSCW perspective with traditional U&G, we see that both gratifications and uses exist across the network of relevant community members. Here, teachers describe both *direct gratifications* they receive themselves, such as the ability manage the classroom by regulating student behavior through music, and *indirect gratifications* others receive, such as children's sense of control over their environment and awareness of the next activity upon hearing the same music. Though teachers made active choices about media engagement to satisfy their own needs, this was part of a larger process, in which they were making usage decisions to satisfy a set of gratifications distributed across a network of actors, with particular attention to children's needs.

Direct and indirect gratifications are likely to be relevant in many collaborative use cases. For example, past work reports on the gratifications that motivate users to tag photos on Facebook, including "gaining popularity" and "entertainment" [29]. Although some of these categories, such as "social sharing," attempt to account for the deeply interconnected nature of social media use, interpersonal relationships are not explicitly probed as a mainline construct within the U&G framing. Expanding the theory to proactively consider both the direct gratifications users seek for themselves and the indirect gratifications they seek for others promises to make it more relevant to CSCW and social computing questions. It then becomes natural to ask not only what users get out of photo-tagging, but also more complex questions about what they hope to do for other members of their network.

The direct-indirect distinction is particularly salient in the context of this study where one group of users (teachers) has a care giving responsibility to another group of users (young children with vulnerabilities that differ from adults). When one user has been entrusted with the needs and care of another, the indirect gratifications they are seeking become central. In research examining, for example, caregivers working with older adults [23] or individuals with disabilities [80], or teenagers taking care of their parents needs [69] or adult children managing their own aging parents [14], proactively considering both direct and indirect gratifications may provide a more robust and productive understanding of the factors driving the use case for the CSCW community.

6 LIMITATIONS AND FUTURE WORK

We visited ten ECE field sites all in the greater Seattle area. Thus, a limitation of this work is the homogeneity in the sample set. The research team was limited in their mobility and was only able to observe ECE environments that were within 30 km of the university. The research team

attempted to address this by choosing environments from across eight different area codes and including field sites with a mix of characteristics, such as those with a high concentration of ELL with disabilities. However, most of field sites that allowed us access charged higher prices than city averages and served a population of families that appeared to be more affluent. Future work can address this limitation by studying a wider diversity of ECE environments and focusing on marginalized and lower-socioeconomic communities.

A second limitation of this work is that observations occurred only once at each field site, in the morning (when the cadence of a preschool day is free from constraints like meals and naps and could accommodate our research team), and lasted no longer than two hours. Presumably, teachers use technology throughout the day, and there may be systematic differences in their usage practices both within a given day and over longer periods of time, which our data would not completely account for. This limitation may be partially mitigated by the fact that these themes were robust across a diverse set of field sites. However, future work following a classroom throughout the day and over time would provide a valuable complement to the findings we report here.

The potential for selection bias and social desirability bias are also limitations of our work. For instance, the centers which agreed to participate in the study may have been more confident in their technology program, and thus were more willing to share. Teachers at centers may have adapted their use of technology in their classroom, knowing that researchers were specifically interested in technology. Although we felt that the patterns in usage of technology were consistent and robust, future work with researchers embedded in a field site over many repeat visits might yield both new findings and greater confidence in the data.

This work does not provide an exhaustive study of how all ECE environments are using technology, but rather this is a deeper look into how technology is currently being used in some environments. Therefore, our themes are formative theoretical generalizations [88], not statistical generalizations [89].

7 CONCLUSION

Early childhood is a critical period when the introduction of technology can have long-lasting effects on a child's growth and development. We applied the *Uses & Gratifications Theory (U&G)* to examine the situated ways in which technology is used in classrooms today (documented through classroom observations), and we further examined the gratifications teachers sought when they enacted these uses (documented through interviews).

We found that teachers make intentional and thoughtful choices in how they use technology in the classroom, motivated by a concise set of common gratifications. The need to support child autonomy, introduce children to a technology-rich world, leverage technology to manage the classroom, among others, led to a vast array of creative and diverse usage scenarios, ranging from pretend play with discarded keyboards to carefully-curated playlists of music to signal transitions.

By distilling the core driving factors that motivate teachers' use, we outline a space of design possibilities–including child-curated music, technologies for dedicated purposes, and tools for child-driven data capture. We also show how U&G currently provides an incomplete picture of the ways in which teachers think about gratifications and translate them into usage behaviors. Thus, a further contribution of this work is an expansion of U&G to include *gratifications resisted* and *direct/indirect gratifications*. Through these new constructs, we hope to make this highly productive, and long-standing theory of greater use to CSCW and social computing researchers.

ACKNOWLEDGMENTS

We are grateful to all the fantastic teachers and directors who welcomed us into their preschools and volunteered to share their experiences with us. We would also like to thank Hansol Kim for excellent research assistance. All errors are our own.

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Received April 2019; revised June 2019; accepted August 2019